Aviation Week and Space Technology

A McGraw-Hill Publication

November 20, 1961

SPECIAL REPORTS:

- X-15 Program
- CL-44 Break-in

North American X-15

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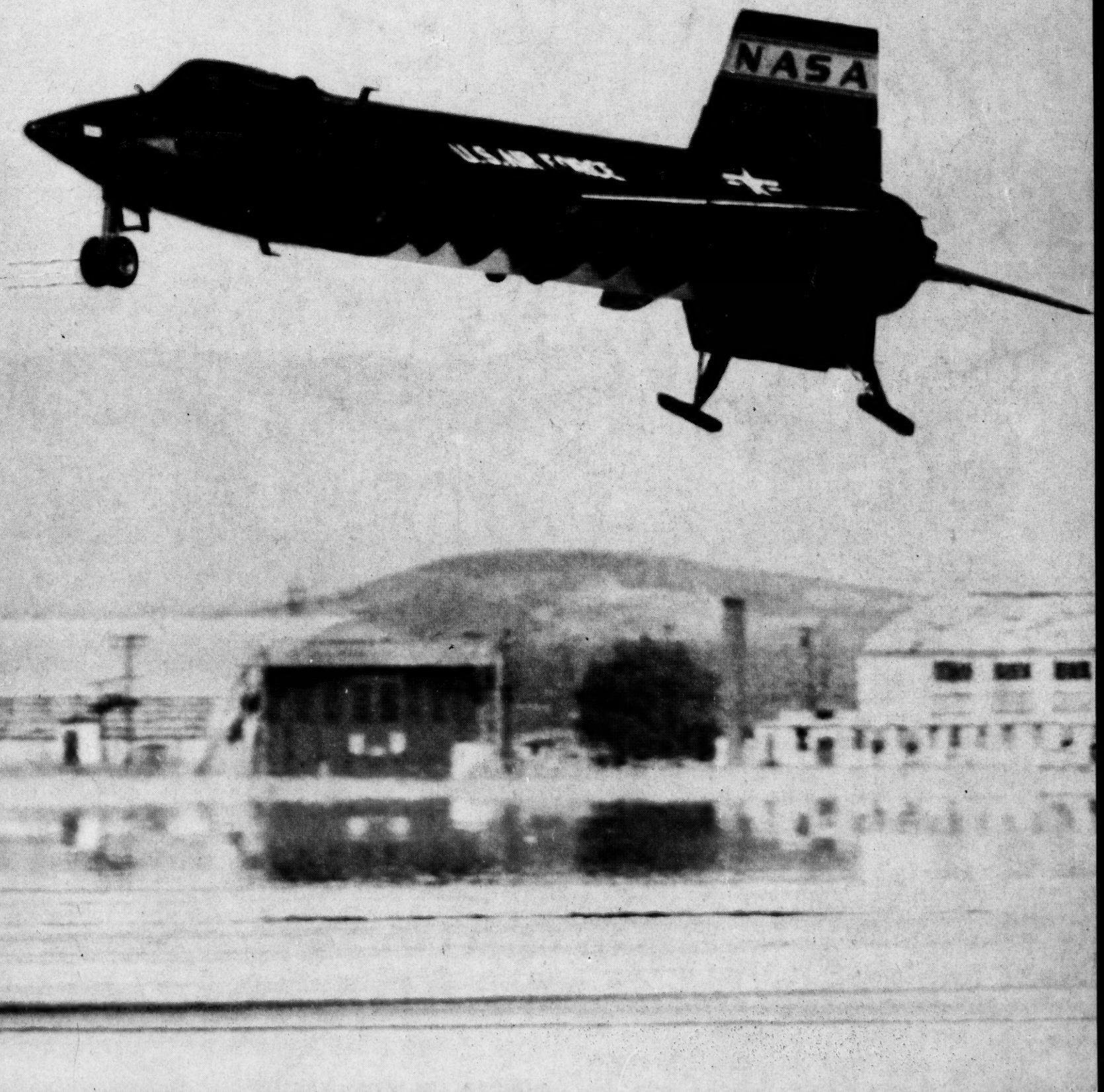

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ov. 27-29—Vehicle Systems Optimization Symposium, Institute of the Aerospace Sciences, Garden City Hotel, Garden City, N. Y.

ov. 27-Dec. 1—Army-Industry Aviation Logistics Symposium, Congress Hotel, St. Louis, Mo.

ov. 28-30—38th Meeting, Aviation Distributors and Manufacturers Assn., Jung Hotel, New Orleans, La.

ov. 30-Dec. 1—12th National Conference, Institute of Radio Engineers' Professional Group on Vehicular Communications, Radison Hotel, Minneapolis, Minn.

ec. 4-5—Beryllium Metallurgy Conference, New York University's Washington Square Center, New York, N. Y.

ec. 4-6—Specialists' Meeting on Aerospace Support and Operations (classified), Institute of the Aerospace Sciences, Orlando, Fla.

ec. 5—11th Annual Meeting, National Air Taxi Conference, Statler-Hilton Hotel, Washington, D. C.

ec. 5-7—Annual Convention, National Aviation Trades Assn., Statler Hilton Hotel, Washington, D. C.

ec. 12-14—Eastern Joint Computer Conference, Sheraton Park Hotel, Washington, D. C.

ec. 18—25th Wright Brothers Lecture, Natural History Bldg., Smithsonian Institution, Washington, D. C.

n. 8-12—1962 Automotive Engineering Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit.

(*Continued on page 6*)

VIATION WEEK and Space Technology

November 20, 1961

Vol. 75, No. 21

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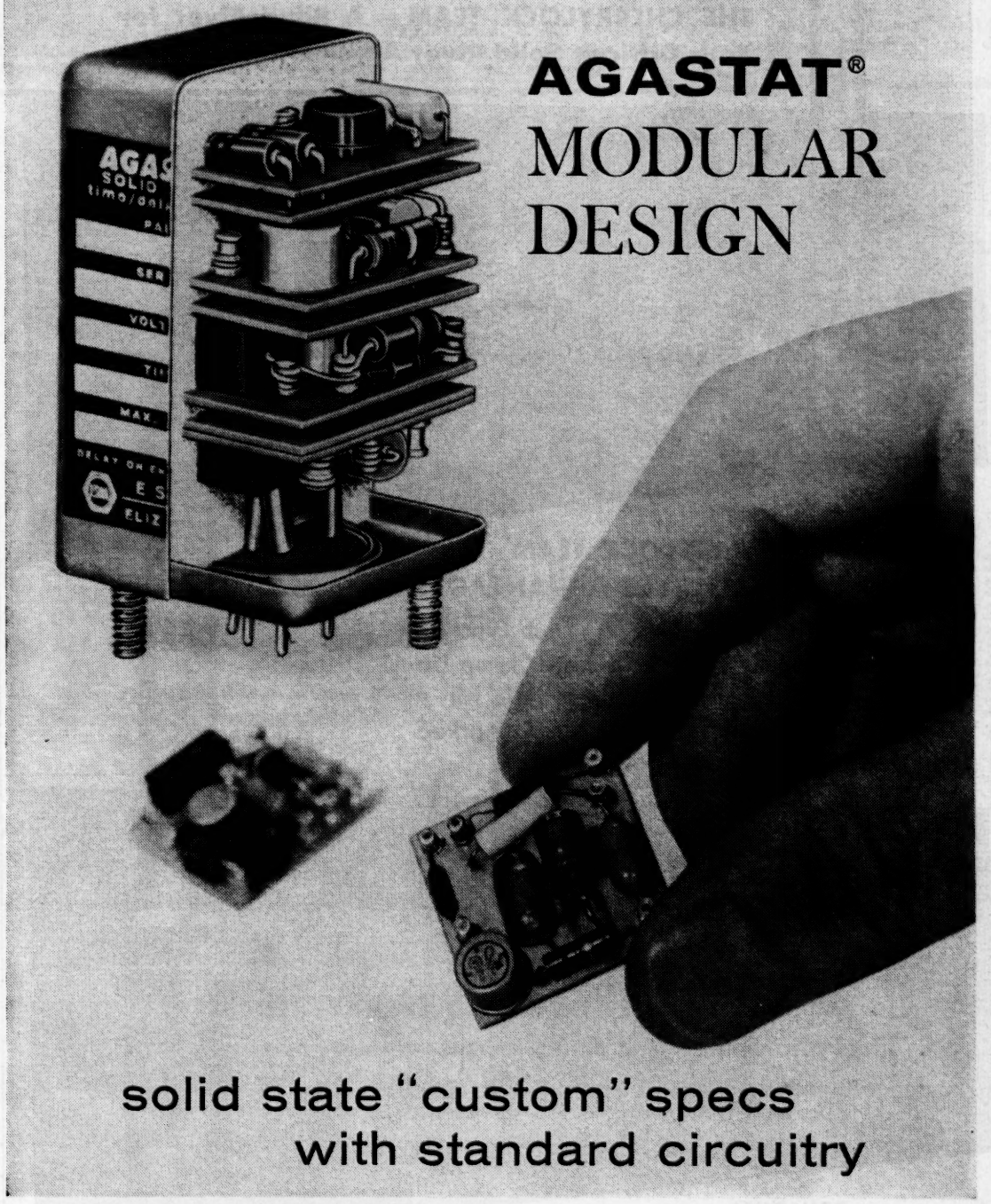

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AEROSPACE CALENDAR

(Continued from page 5)

Jan. 9-11—Eighth National Symposium o Reliability and Quality Control, Statle Hilton Hotel, Washington, D. C.

Jan. 15-17—Symposium on Optical Chara ter Recognition, Department of the Int rior Auditorium, Washington, D. C Sponsored by Information Syste Branch/Office of Naval Research and R search Information Center/National B reau of Standards.

Jan. 21-24—Annual Meeting, Helicopt Assn. of America, Marriott Motor Hotel Dallas, Tex.

Jan. 22-24—30th Annual Meeting, Ins tute of the Aerospace Sciences, Hotel A tor, New York, N. Y. Honors Nigh Dinner, Jan. 23.

Jan. 23-26—Third Annual Solid Propellan Rocket Conference, American Rock Society, Baylor University, Waco, Tex.

Jan. 24-26—Second Symposium on Therm physical Properties, Princeton, N. J. Spon sor: Heat Transfer Division, Americ Society of Mechanical Engineers.

Feb. 6-7—Symposium on Redundancy Tech niques for Computing Systems, Depar ment of the Interior Auditorium, Wash ington, D. C. Sponsor: Information Sy tems Branch, Office of Naval Research.

Feb. 7-9—Third Winter Convention o Military Electronics, IRE, Ambassado Hotel, Los Angeles.

Feb. 14-16—International Solid-State Ci cuits Conference, Institute of Radio En gineers, Sheraton Hotel and University Pennsylvania, Philadelphia, Pa.

Feb. 19-21—Range Reconnaissance an Tracking of Aerospace Vehicles, Institut of the Aerospace Sciences, San Fran cisco.

Feb. 27-Mar. 1—Third Annual Symposiu on Nondestructive Testing of Aircra and Missile Components (unclassified Gunter Hotel, San Antonio, Tex. Spon sors: South Texas Section-Society for Non destructive Testing; Southwest Researc Institute.

Feb. 27-Mar. 1—Symposium on the Appli cation of Switching Theory in Space Technology, Palo Alto, Calif. Sponsors Lockheed Aircraft Corp.; Air Force Office of Scientific Research.

Mar. 1-3—Eighth Scintillation and Semicon ductor Counter Symposium, IRE, Shore ham Hotel, Washington, D. C.

Mar. 5-8—Seventh Annual Gas Turbine Con ference and Products Show, American So ciety of Mechanical Engineers, Sham rock Hilton Hotel, Houston, Tex.

Mar. 8-9—Institute of the Aerospace Sci ences' Flight Propulsion Meeting (class fied), Cleveland, Ohio.

Mar. 14-16—Electric Propulsion Conference American Rocket Society, U. S. Nava Postgraduate School, Monterey, Calif.

Mar. 26-29—International Convention, In stitute of Radio Engineers, Coliseum and Waldorf Astoria, New York.

Mar. 28-29—Third Symposium on Eng neering Aspects of Magnetohydrodynam ics, University of Rochester, Rochester N. Y. Sponsors: American Institute o Electrical Engineers; Institute of the Aero space Sciences; Institute of Radio Eng neers; University of Rochester.

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Defense to Emphasize Incentive Contracts..... **26**
▶ Civilian chiefs ready to insist on reward-or-penalty approach to cut costs, improve quality of weapons.

Critics Push IATA Organization Changes..... **36**
▶ Small airlines, rebuffed at convention, press bid for stronger voice, expanded executive committee.

X-15 Objectives Raised to New Limits..... **52**
▶ Test data indicates that the rocket-powered X-15 will exceed its design limits by 100% in altitude and 17% in speed.

SPACE TECHNOLOGY

Radioisotopic Fuel Tested..... 27
GT&E Endorses Comsat Plan..... 28
GE Tests Re-entry Heating..... 29
AEC, Air Force Facing Spur Showdown 30
NASA Studies Rendezvous Concepts.. 32
Transit Checks Gravitational Field.. 34
Soviets Reject Weather Satellite Plan. 34
U. S. Manned Orbit Plans..... 35
Arab Rocket Reports..... 35
X-15 Objectives Raised to New Limits 52
Group to Study U. S. Scientific Needs 67
NASA Reorganization Chart..... 71

AERONAUTICAL ENGINEERING

Alternate LOH Engine..... 26
French Consider C-130..... 26
New X-15 Windshield to Be Tested... 30
Tri-Service VTOL Transport Design... 31
CL-44 Expanding Cargo Market..... 72
Sikorsky S-64 Rotor System Tested.. 83
Production Briefing..... 86

MISSILE ENGINEERING

RL-10 Engine Passes Early Testing.... 27
Airborne Slam Tracking Stations.... 103

FINANCE

LTV $13-Million Loss Announced..... 30

BUSINESS FLYING

Plastic Piper Nears Flight Stage..... 34
Custom Firm's Light Aircraft Plans... 107

AIR TRANSPORT

Critics Push IATA Changes..... 36
Supplemental Lines Investigated..... 37
General Electric Engine Service..... 38
Northeast to Ask for Subsidy..... 39
Domestic Traffic Rise Noted..... 40
KLM Deficit Blamed on Low Fares.... 40
International Carrier Slump Continues 41
Swiss Line Expands Piston Fleet..... 43
Airline Observer..... 50
Shortlines..... 50

MANAGEMENT

DOD Incentive-Penalty Contracts.... 26
Hoffa at Sikorsky..... 27
DOD to License Private Comsat Groups 28
New Army Commands Proposed..... 35
Swiss Emphasize Pilot Abilities..... 111
Industry Observer..... 23
Who's Where..... 23
Washington Roundup..... 25
News Digest..... 35

AVIONICS

Integrated Circuits to Be Marketed.. 89
X-15 to Test Adaptive Control System 95
Filter Center..... 101

Calendar..... 5
Letters..... 126

EDITORIAL

Salute to the X-15..... 21

COVER: North American's X-15 supersonic research aircraft is shown over north lake bed of Edwards Air Force Base. Photo was taken by high-speed automatic Hulcher camera equipped with telescopic lens. The aircraft recently set a new speed record of Mach 6.04 at an altitude of 95,800 ft. (AW Nov. 13, p. 33). For details of the X-15 program and new objectives see p. 52.

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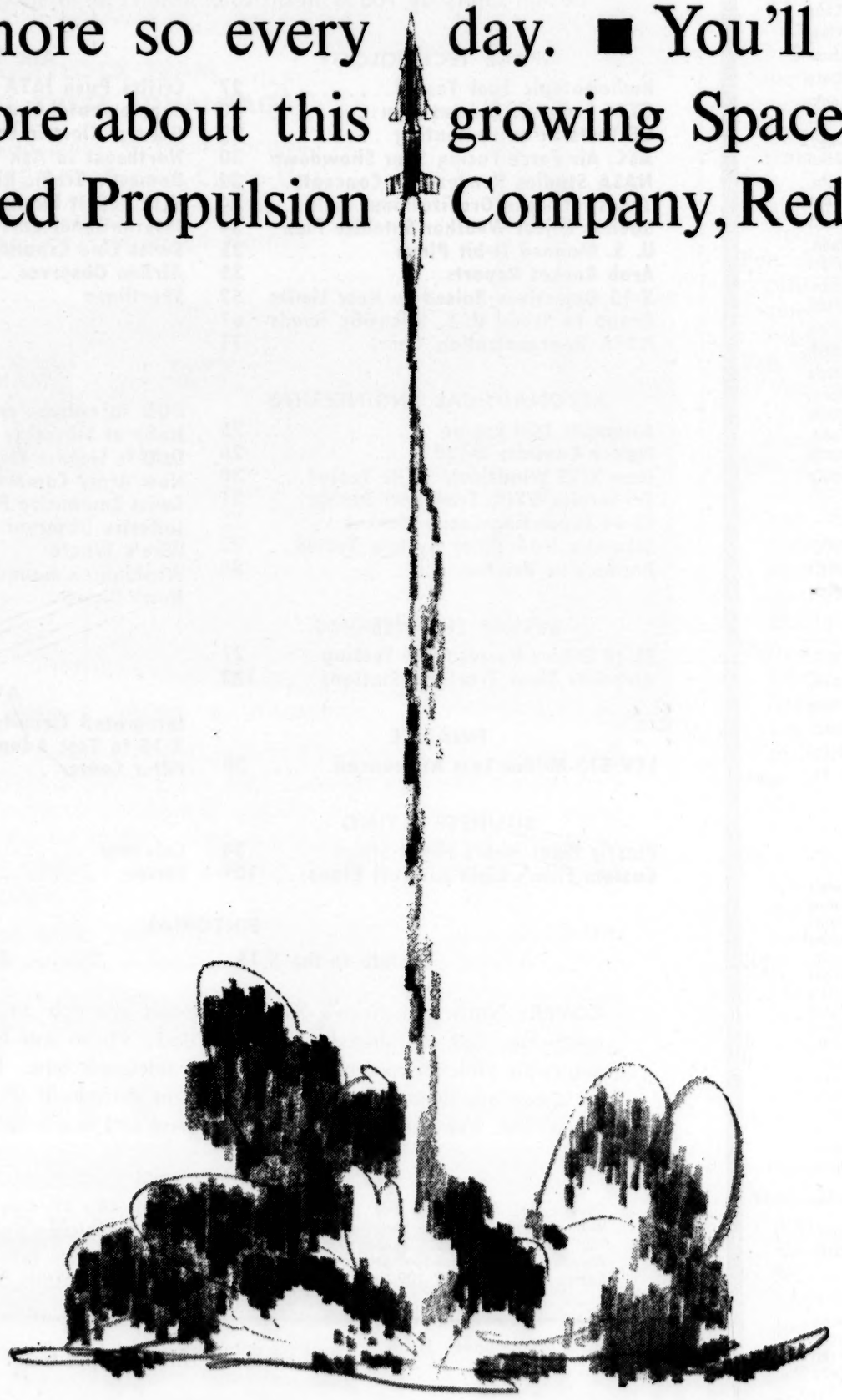

EDITORIAL

Salute to the X-15

The joint USAF-Navy-NASA research program with three North American X-15 aircraft has reached a significant milestone, with performances of Mach 6.04 (4,093 mph.) and 217,000 ft. altitude that fulfilled its original design requirements established by the National Advisory Committee for Aeronautics' aerodynamics committee in 1954. Although these requirements of Mach 6 and "several hundred thousand feet altitude" have already been surpassed by USAF Test Pilot Maj. Bob White, there is still appreciable stretch left in the X-15's ultimate performance (see p. 52). The basic research fall-out from this program will continue well into 1963, with detailed exploration of the areas already staked out by incremental performance increases to their present peaks.

To date, the X-15 flight research program has been the most successful in the history of this series of research aircraft that began with the Bell X-1. It seems certain that the X-15 program will produce a greater amount of useful data than all other previous research aircraft programs combined. It has certainly given the United States a commanding lead in manned vehicle technology in the previously unexplored frontier between Mach 2 and Mach 6, and in the extreme ranges of altitude beyond the main atmospheric envelope of the earth. The X-15 program has proved beyond question the necessity of having a man aboard space vehicles of the future. Some 24 of the 45 powered X-15 flights would not have completed the specified mission—in at least 10 cases with complete destruction of the vehicle without the ability of the pilot aboard to handle the system malfunctions, provide intelligence or switch his mode of operation.

This program has provided a vital foundation of knowledge in controlled re-entry from outside the atmosphere, and in precise pilot control of large rockets during the brief (some 70 sec.) but critical initial powered phase of the X-15 flights. Other gaps these flights have filled include intense aerodynamic heating up to 1,200F, reaction control systems and human factors in the hostile environment of extreme altitude. The research fall-out from this X-15 program will extend over a wide area from supersonic airliners to the Apollo lunar exploration space vehicle and military space vehicles.

The origin, development and management of the X-15 program is also a shining demonstration of how significant technical progress can be achieved by the American system in minimum time, with the whole-hearted cooperation and support of a wide variety of governmental and industrial organizations. From its inception it was a truly joint program, drawing on the best technical brains, industrial resources and pilot capabilities this country had to offer. These resources were backed by the management courage in USAF-NASA and the Navy to push firmly into the unknown where the odds for success are never great, and to support the program resolutely throughout its development period. Unfortunately, this may be the last such program to follow this successful pattern if the sad case of the Dyna-Soar, studied and re-oriented almost to death, is any portent of the future. How the research gap between the end of the X-15 program and the beginning of the Apollo program will be closed in time to be effective is one of the most critical problems facing the nation's technical managers today.

In this limited space, it is impossible to credit all of the organizations and individuals who contributed to the outstanding success of the X-15 program. But there are some who merit special mention. The names of the principal X-15 pilots—North American's Scott Crossfield, USAF's Bob White and NASA's Joe Walker—are now extremely well known and they have won the Harmon International Aviators Trophy for their efforts. Crossfield also contributed pilot-engineering input from his Mach 2 experience in the Douglas Skyrocket to the X-15 development phase.

Certainly Harrison Storms, of North American, and Walt Williams of NASA have played as large a role as anybody in the X-15 program from its very inception. Storms' role extended from the years when he served on the NACA aerodynamics committee that created the requirement, through the design phase and flight test program. He not only headed the group that designed the X-15, but made many personal contributions to its unique configuration, including the lateral tunnels along the fuselage and the controversial empennage. Among his principal assistants were Charles Feltz, X-15 project engineer, and John Gibb, who designed the fuel system—one of the most critical installations in the X-15. On the propulsion side, Reaction Motors' Project Engineer Bob Seamans headed the design and development of the XLR99 rocket engine that powered the record-breaking X-15 performances.

In the conceptual stage which stretches back to 1951, the late Bob Woods, vice president of Bell Aircraft Corp. and designer of the X-1, X-2 and X-5; the irrepressible John Stack, Walt Williams and Hartley Soule of NASA, and Bailey Oswald of Douglas played strong roles. After Bob Wood's presentation to the NACA aerodynamics committee in 1952 outlining the need for a Mach 6 research aircraft—at a time when Mach 1.7 was the fastest man had flown—it was the quiet and often unappreciated persistence of Dr. Hugh L. Dryden, then director of NACA, that supported his laboratory researchers at Langley and Ames in a special two-year research program. This program was aimed at laying the technical foundation that made design of the X-15 feasible when the decision to proceed was made in the fall of 1954. USAF's system project officers, Maj. Kit Murray and Capt. Chester McCullough, were key men in the military's technical management and funding of the program.

In the operational phase Walt Williams, who headed the NASA high speed flight research center at Edwards until being drafted to the Mercury project, and Paul Bikle, who succeeded him at a critical phase in the X-15 program, deserve special credit, as do the North American test engineers George Mellinger, Roy Farren, Quentin Harvey and Blake Staub. Unsung heroes of the flight test program were the B-52 mother plane pilots, Capt. Charles Bock and Capt. Jack Alavie. Other pilots who have flown the X-15 include Lt. Cdr. Forrest Peterson, Neil Armstrong and Jack McKay of NASA and Capt. Bob Rushworth of USAF.

Among the industry contributions supporting North American were Reaction Motors division of Thiokol, developers of the XLR99 rocket; Northrop for its Q-ball nose; Bell Aerospace Systems for its control rockets; Minneapolis-Honeywell, Lear and Sperry for their contributions to the control system; International Nickel Co. for its Inconel X used for the heat-resistant structure and more than 250 other firms whose contributions filled out this successful pattern.

The X-15 program has already earned a shining spot in the technical history of our times. Its research fall-out will repay many, many times the original investment of the taxpayer's dollar in this program.

In light of the many management wrangles and uncertain patterns developing in current research programs aimed at pushing still farther into the unknown, it might be a good idea to re-study the technical managerial pattern of the X-15 program and apply its lessons to the future.

—Robert Hotz

LACK OF RECONNAISSANCE-IN-BEING BLINDS THE ALLIES AT SINGAPORE

The Japanese . . . how many, where were they? This was the British dilemma throughout the remarkable fifty-five day campaign which saw the invading Japanese forces knife their way through the Malayan Peninsula and into the "impregnable" fortress of Singapore.

Obviously, the jungle terrain compounded the confusion. Although the British had twice as many men, twice as many tanks and trucks, they had virtually no aerial reconnaissance capability to provide tactical information for battlefield commanders.

Conversely, Japanese "Dinahs" had flown aerial reconnaissance before hostilities began and were invaluable in locating existing military airdromes and determining terrain details for subsequent action. Blinded by lack of reconnaissance, defending forces always believed the attacking Japanese far greater in strength than they were.

Could British forces have repelled this Japanese attack with adequate reconnaissance? It's difficult to say. Still, a stronger aerial reconnaissance capability could have provided information that would have molded a puzzled defense into a wiser, more formidable foe . . . would have transformed a fifty-five day lightning thrust into a far more costly stalemate operation for the Japanese.

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Frederick R. Kearns, vice president of Canadair, Ltd., has been elected president of the Air Industries & Transport Assn. of Canada. Other officers: **J. A. M. Austin,** of Austin Airways, Ltd., vice president-transport; **W. S. Haggett,** of Bristol Aero Industries, Ltd., vice president-industry; **John H. Baldwin,** of Honeywell Controls, Ltd., honorary secretary; **H. D. Cameron,** Canadian Pacific Air Lines, honorary treasurer.

J. F. Dempsey, general manager of Irish International Airlines, has been elected president of International Air Transport Assn. for 1962-63.

Sen. A. S. Mike Monroney (D.-Okla.), chairman of the Senate Aviation Subcommittee, will receive the National Aeronautic Assn.'s 1961 Wright Memorial Trophy at the Aero Club of Washington's annual Wright Day Dinner, Dec. 18.

W. Jerome Kane, manager of export sales for the Transport Division of The Boeing Co., has been elected chairman of the Export Committee of the Aerospace Industries Assn. for 1962. **Joseph M. Barr,** president of United Aircraft International, Inc., was named honorary chairman of the Committee, and **T. Norman Labash,** Washington representative for the International GE Co., was named vice chairman.

(*Continued on page 121*)

INDUSTRY OBSERVER

► Emphasis is being placed on surveillance, maintenance and rescue tasks for the Dyna-Soar boost glider in the current Defense Department review. Vehicle is no longer being pushed as a potential offensive weapon system. Present design has 75 cu. ft. belly volume for installation of about 1,000 lb. of payload.

► **Contract for an off-the-shelf configuration of Navy's ASH (assault support helicopter) is expected soon, possibly next week. Program calls for purchase of about 300 machines at a fixed price over the next four to five years. Specifications will call for a five-place helicopter with a 450-eshp. turbine engine.**

► Based on compatibility tests made in the U. S., Britain's Royal Air Force is studying the possibility of making a major modification to the wing design of the Vulcan bomber if a decision is made to fit the aircraft with four USAF-Douglas Skybolt air-launched ballistic missiles. Current plans call for only two missiles to be carried.

► **Growth versions of the Air Force Spur (space power unit reactor) may be developed by adopting a modular concept in which basic components would be duplicated to provide two or more complete power loops. Duplication probably would not include the reactor, which would be a new, larger design. Modular Spur would be less vulnerable to meteoroid strikes because a single strike would damage only a part of the system, allowing the over-all system to continue to operate at a reduced power level.**

► General Electric is conducting research and development for Air Force on a radio guidance system that could be used on a Dyna-Soar glider booster for Step 1 (suborbital) flights.

► **Radiative properties of rocket plumes of various propellant combinations will be analyzed by North American Aviation's Rocketdyne Division for Air Force. Work will encompass a wide spectral range at simulated altitudes up to 100,000 ft.**

► Ford's Aeronutronic Division is developing an intercontinental ballistic missile decoy injection system as a follow-on to earlier decoy design and fabrication contracts from Air Force.

► **Administration of a Battelle Memorial Institute study of environmental effects, including nuclear radiation, on solid propellant storage systems will be transferred soon from NASA's Marshall Space Flight Center to Jet Propulsion Laboratory.**

► Development of a mobile Minuteman may be approved just after the first of next year. Meanwhile, the program has been under limited development with no approval for an operational system.

► **First flight of the Dassault Mirage III-V Balzac VTOL fighter is planned for next year. Balzac, the main French entry in the NATO VTOL competition, is a Mirage III retrofitted with eight Rolls-Royce RB-108 vertical lift turbojets and one Bristol Orpheus III turbojet for forward flight. French government is financing the single prototype, with the work being done by Dassault and Sud Aviation.**

► North American Aviation's Space and Information Systems Division is locating by analytical method satellite debris and satellites that have quit transmitting and then is verifying identity optically as part of an Air Force program to identify all artificial objects now in space near the earth. As of Nov. 7, there were 113 objects in such orbits, and only 10 were transmitting.

► **Work on some 1,500 mi. of subsurface cable installation for the USAF Minuteman missile Wing III at Minot, N. D., is scheduled to begin next June and will require approximately a year and a half to complete.**

SILICOLOGY

Studies in Silicones

HOW THESE TIME-TESTED MATERIALS CAN WORK FOR YOU

Turn on the heat—
Silicone-based coatings can take it!

If you were to list the outstanding characteristics of silicone resins, chances are that "heat resistance" would rate near the top.

Paint manufacturers who formulate high-temperature coatings have long been aware of this important property and are turning more and more to silicone resins as a base for their products. These range all the way from high-temperature enamels for electrical appliances to special paints used on rockets and missiles, jet aircraft engines, and other advanced space vehicles.

In many cases, the choice in silicone resins inevitably leads to one made by UNION CARBIDE, not only because of their unmatched reliability and uniformity, but because each has been scientifically designed to meet a specific paint requirement.

LOW-TEMPERATURE CURE

Take UNION CARBIDE R-630, for instance, a new low-temperature curing resin which has been widely adopted by the paint industry as a base for appliance finishes and for paints on engines, motors, generators and other high-temperature electrical equipment. Enamels based on R-630 are free from many of the handling problems inherent in the use of other silicone varnishes and may be applied over any metallic surface by spraying, flow coating, brushing, or dipping. Lighter in weight, more flexible and less expensive than ceramic coatings, it can be blended with acrylic enamels to give them improved thermal stability and resistance to weathering.

The color range is virtually limitless, and high-temperature enamels based on R-630 have outstanding durability, salt spray resistance and water-repellency. In addition, paints based on R-630 can be packaged in aerosol sprays for consumer use on home ovens, stoves and radiators.

LOW-COST ALUMINUM PAINTS

To combine economy with performance, many large-scale users of paints are adopting UNION CARBIDE R-64, a silicone resin which can be cold-blended easily

Silicone base aluminum paint, which provides surface protection up to 1700 deg. F., is sprayed on rocket engine jig at Rocketdyne plant of North American Aviation. The paint, known as CI "Extra High," is made by Chem Industrial Co., Cleveland, O., and is based on silicone resins made by Union Carbide.

with many organic resins as vehicles for aluminum paints. With only 7 to 11 per cent by weight of resin needed in the formulation, aluminum paints of this type give outstanding protection in the 500-1200 deg. F. range and still retain their silvery appearance under these high-temperature conditions.

Applied by brush or spray, such paints are used as protective coatings for aircraft engines and exhaust stacks, truck and engine manifolds and mufflers, furnaces, ovens, stove and heater doors, and metal smoke stacks. Heat and flame-resistant protective clothing can also be fabricated from asbestos cloth coated with aluminum paints based on R-64 organic blends.

MAXIMUM THERMAL STABILITY

If factors of heat, weather and corrosion constitute a major problem for you, take a look at still another UNION CARBIDE product, R-611. Developed specifically as a resin vehicle for metallic and non-metallic pigmented high-temperature enamels, it provides the *ultimate* in thermal stability and offers far greater heat, weather and corrosion resistance than organic paints. Typical applications are in paints for ovens, incinerators, high-temperature electrical appliances, lamp shields and reflectors, smoke stacks, piping, engines, motors, generators and high-temperature processing equipment such as are found in many chemical and metallurgical industries.

R-611 based paints can also be packaged in aerosol sprays for consumer use on home ovens, stoves and radiators.

LASTING QUALITY

Silicone-based coatings mean savings because they provide protection for longer periods of time. If you have a coating performance problem, look to UNION CARBIDE Silicones for your answer. Your Silicones Man is at your service. Behind him is not only his know-how, but the vast experience and research of Union Carbide Corporation in virtually every field of industry. For information and help, fill in the attached coupon and mail it today.

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Washington Roundup

Presidential Prestige

White House intervention in airline labor disputes has become the major goal of both labor and management factions, with each side seeking the psychological advantage that findings by a presidential commission carry. Recent creation of emergency boards to avert threatened pilot walkouts at Trans World Airlines and Pan American World Airways is regarded as a successful tactical maneuver by the Air Line Pilots Assn. to enlist more support for its contract demands. Management also benefits by avoiding a costly strike and gaining an opportunity to present its side to a third party. Decisive factor in settling these ALPA issues and the pilot-vs-engineer cockpit dispute will be the Feinsinger Commission report. Although its recommendations are not binding, the White House has had sufficient indication from both sides to believe that a settlement will be reached in the near future that closely follows the commission's suggestions.

One of the first Project Beacon report recommendations to come under fire is the one suggesting establishment of a new Controlled Visual Rules (CVR) category for pilots without instrument ratings. Critics claim this will impose an additional burden on the traffic controller by requiring him to keep abreast of current weather conditions so he won't assign CVR pilots to altitudes where they might encounter instrument conditions, even briefly.

'Acrobatic Team'

U. S. is describing the four McDonnell RF-101 reconnaissance aircraft that have been flying from Saigon's international airport since Oct. 22 as "an acrobatic team." The U. S. embassy in Saigon said they came there for celebration of South Vietnam's National Day Oct. 26, which was canceled, and stayed "to log some flying time." Saigon sources say they are flying photo recon missions over Vietnam, Laos and Cambodia. Meanwhile, Douglas C-124 Globemasters have been delivering cargoes of small arms, vehicles, electronic equipment and armed "all-purpose" helicopters. The South Vietnamese air force is now flying four Douglas B-26 bombers where before it had only transports and Douglas AD-6 attack bombers.

Logistics Management Institute, publicly heralded as a new research organization for improving Defense Department procurement policies, also is being counted on to stay ahead of congressional committee and General Accounting Office investigators by spotting any irregularities first so they can be corrected before they become celebrated causes.

FABMIDS Review

Army's Field Army Ballistic Missile Defense System (FABMIDS) program is under review by Dr. Harold Brown, director of defense research and engineering, following completion of Phase I studies by five contractors. Army is undecided whether to proceed with the heavier, more sophisticated system proposed by General Electric or the less complex system proposed by four other contractors. If the lighter system is adopted, Raytheon is considered the most likely winner of the Phase II development contract.

The flood of criticism of the number, frequency and length of technical society meetings and the practice of scheduling as many as six sessions at once is having an effect on at least one organization. From now on the American Rocket Society will limit its semi-annual meeting to a single theme and will schedule one session at a time, with a recognized expert in a particular field delivering an over-all paper and other contributors delivering shorter ones. ARS is even trying to make sure the auditorium seats are comfortable enough to keep listeners there through the whole meeting. Until now, the semi-annual meeting has been a smaller version of the annual meeting, covering a whole range of disciplines. The 1962 session, scheduled for Cleveland next June, will deal only with lunar exploration.

Northeast Finances

Northeast Airlines' financial plight **(see p. 39)** **has recalled Civil Aeronautics Board Chairman Alan Boyd's answer to a question after his recent speech** on fares and mergers (AW Nov. 6, p. 37). He said the Board would have great reluctance to see a carrier go into receivership—a term he used as more accurate than bankruptcy. Boyd said his speech, which proposed an ideal of two carriers to a route and specified the need for capital strength to support airline operations, was not necessarily directed at the Northeast situation. The Florida market, he said, is an exception—a market large enough to support more than two carriers.

Dr. Dale Smith, a former Air Force veterinarian and one of the first military officers to be assigned to National Aeronautics and Space Administration, will become deputy director of NASA's Life Sciences Laboratory at Ames Research Center on Dec. 1. He resigned from USAF early this year to become a permanent NASA employe.

Chairman John E. Moss of the House Government Information Subcommittee, decrying the use of gobbledygook in government, said that to a bureaucrat the word "program" means "any assignment that requires more than one telephone call to settle."

—Washington Staff

Defense to Emphasize Incentive Contracts

Civilian chiefs ready to insist on reward-or-penalty approach to cut costs, improve quality of weapons.

By George C. Wilson

Washington—Defense Department has moved beyond the general study stage and is now ready to write a wide variety of incentive-penalty contracts with industry in the belief that they will cut costs and improve the quality of weapon systems.

This decision will revolutionize traditional defense-industry relationships at the bargaining table by shifting the emphasis from initial cost estimates to means for measuring and rewarding the contractor's performance. This new emphasis also is certain to prompt industry to provide better quality control.

Industry itself has participated in Defense studies of incentive contracts, and although there are numerous problems to solve, industry appears willing to try the incentive approach. Less certain is how Congress will react to wider use of these contracts and whether the renegotiation board will refrain from taking away the bigger profits.

The House Armed Services Committee long has been wary of the incentive contracts that Defense Department has tried so far. A committee staff member who investigated this type of contract in 1959 said last week: "I'm not saying incentive contracts are not workable, but so far they have not worked." The House Armed Service Special Investigations Subcommittee is expected to investigate some of the new incentive contracts after they are negotiated.

Thomas D. Morris, assistant secretary of defense for installations and logistics, told AVIATION WEEK that Congress' skepticism about incentive contracts in the past will not deter efforts to broaden their use. "Our clear objective" is to develop the case for incentive contracts and then "let the facts speak for themselves," Morris said.

The Air Force and Navy will move faster than the Army in broadening the use of incentive contracts, primarily because they have had more experience with this type. But Paul R. Ignatius, assistant secretary of the Army for installations and logistics, said this does not mean the Army will continue to shy away from incentive contracts. "It's either a good idea or it isn't," he said. "My own personal view is that we can and should widen the use of performance incentives."

Until now the Army had made little use of incentive type contracts. Ignatius said this stemmed from the "sincere conviction" of procurement officials that reimbursable and other types of contracts were preferable. Now, he said, those policies will be reappraised and the Army will make maximum use of firm fixed-price contracts in lieu of cost-plus-fixed-fee types as well as exploring ways to use incentive contracts.

Joseph S. Imirie, assistant secretary of the Air Force for materiel, said industry had "complained all these years" that it needed to make more profit on Air Force contracts, but had yet to propose a specific contract formula for accomplishing this, even though it had been invited to do so. The message for industry, he said, is: "Get with it."

Imirie stressed that the challenge in working out a contract formula is "marrying industry's proposal (for providing more incentive) with Air Force's objectives of reliability and cost . . . We've got to have more reliability." He urged companies interested in Air Force proposals to offer their own formulas for putting more incentive into the contract.

Similarly, Vice Adm. G. F. Beardsley, chief of the Office of Naval Materiel, said his procurement officers have been told to be receptive to industry proposals for incentive contracts. A recent directive over his name states that it is Navy policy "to support the principle of higher profits for superior contractor performance and lower costs, provided this principle requires reduced rewards for poor performance and excessive costs."

It also said it is Navy policy "to encourage increased use of firm fixed-price contracts, incentive contracts and other forward pricing procedures, and to discourage the use of cost-reimbursement type contracts and other forms of retroactive pricing." Incentive provisions, the directive said, may be based on cost, performance, reliability, quality and delivery of the product.

Right now, Adm. Beardsley said, the Navy is trying to develop an incentive contract for "a big missile system." The key problem, he said, is devising ways of measuring performance. A possibility, he said, is to measure performance from three standpoints of equal weight: cost, performance of the weapon and reliability of its systems.

Morris, who is overseeing the overhaul of contracting policies of all three services, readily admits that measuring performance is no easy task. But he cites figures to explain why he feels the Defense Department must try new contracting methods.

Basically, the figures show that use of the cost-reimbursement contracts has doubled between Fiscal 1952 and Fiscal 1961, while the use of the fixed-price contract has almost halved. Significantly, the use of incentive contracts has remained almost the same in the 10-year period. Morris and other top policy makers feel the cost-plus-fixed-fee contracts are undesirable because the contractor is paid without any regard to the quality of his work. They hope to limit these contracts largely to research projects.

The dollar value of Defense Department contracts was apportioned this way between Fiscal 1952 and 1961:

	FY 1952	FY 1961
Fixed Price	Percentages	
Firm	29.8	31.5
Redeterminable	38.5	10.5
Incentive	12.0	11.2
Escalation	1.8	4.7
Total	82.1	57.9
Cost reimbursement		
No fee	4.5	2.0
Fixed fee	13.3	36.6
Incentive fee	—	3.2
Time and materials	0.1	0.3
Total	17.9	42.1

Alternate LOH Engine

Washington—Army plans to request proposals next month for an alternate engine for its light observation helicopter (LOH). Allison T63 engine, developing about 250 eshp., is being used in the 15 LOH vehicles now being built for a two-year test program. Bell, Hiller and Hughes are building five each for the tests. Contractors at an Army briefing last week included AiResearch, Boeing, Continental, Canadian Pratt & Whitney, Lycoming and Allison.

French Consider C-130

Washington—French Defense Ministry has started negotiations with the U.S. Air Force to purchase approximately 18 Lockheed C-130 transports. Defense Minister Pierre Messmen, who will visit Washington later this month, said in National Assembly debate that the French are interested in the C-130 to "honor commitments on Berlin."

Objection to the purchase has been made by the French airframe industry, but U. S. sources indicate the objection has been overcome.

Hoffa at Sikorsky

Industrial Division of the Teamsters union, supported with a personal appearance by its leader, James Hoffa, is seeking to become bargaining agent for Sikorsky Aircraft's 5,000 hourly employes.

A National Labor Relations Board election Nov. 29 will determine whether the hourly employes want representation by the Teamsters, by the Independent Aircraft Guild, or no union.

The Guild was organized after the United Auto Workers union was decertified as bargaining agent last year following a protracted strike. It succeeded in obtaining 30% membership of employes required to request an NLRB election. Opponents of the Guild charge that it is a company union.

Teamsters also have shown interest in moving into Lockheed-Marietta, and Hoffa invited key employes to a meeting there last summer. There have been meetings since (AW Aug. 21, p. 34).

Subtracting the incentive-type contracts in both categories, shows that the percentage of fixed-price contracts declined from 70.1% to 46.7% between Fiscal 1952 and 1961 while cost-reimbursement types rose from 17.9% to 38.9% in the same period. Incentive contracts in both categories rose from 12% to 14.4% between Fiscal 1952 and 1961.

Philosophically, Morris is convinced that wider use of incentive contracts will save money and give Defense better products because "over the long run, a company's incentive to earn more is the keystone of its effort to produce better products at lower prices. When its incentive is depressed, the drive to achieve more economical production is weakened and ultimately we are the losers."

He favors a wider range of profits under existing incentive contracts as well as fuller use of them and development of new formulas.

On cost-plus-incentive-fee contracts, he feels profits should range all the way up to the 15% maximum instead of the present range of from 4.5% to 9%. On fixed-price-incentive contracts, he feels the government-industry split on money saved should be increased from the usual 80-20% or 75-25% to as much as a 50-50 ratio.

One idea—and Morris stresses it is still just an idea—for a new type of incentive contract is to let an independent board appraise the contractor's finished work and decide what the percentage of profit should be. This range, Morris said, could be from −5% to +15%.

Industry itself is studying new types of incentive contracts. The National Security Industrial Assn. has appointed a committee to do this, comprised of S. W. Cable, secretary of Camloc Fastener Corp., G. W. Frost, accounting specialist for General Electric Co. and J. J. O'Neil of Cornell Aeronautical Laboratory.

George F. Metcalf, a General Electric regional vice president for Washington Defense activities, studied incentive contracts for the Aerospace Industries Assn. He said an intensive analysis of the incentive contracts GE had negotiated with the Air Force for space re-entry vehicles indicated that performance incentives "offers some real promise" in the research and development field. He said GE feels such performance incentives promote efficiency within industry, cut costs and give Defense higher quality weapons. Metcalf was scheduled to discuss the results of his contract analysis with Defense Department officials last week.

The decision to broaden the use of incentive contracts, Morris said, is the result of the Kennedy Administration's "new team taking a fresh look." Some Pentagon officials predict savings of up to $200 million a year.

Secretary of Defense Robert S. McNamara launched the Pentagon's economy drive and is giving it continuing attention. He told the National Security Industrial Assn. last June that both Defense and industry "must pay a good deal more attention to the relationships between costs and benefits."

At the same time, McNamara and other top Defense officials have pledged to revise and simplify their own procedures in order to help save money. For example, they have promised to minimize the number of changes in a weapon once its development is under way.

Defense Department's recently established Logistics Management Institute will analyze the Pentagon's buying practices and recommend improvements. One of its first studies was in procurement of aeronautical spare parts. On the basis of LMI's recommendations, Morris plans to double the percentage of aeronautical spare parts purchased through competitive bidding—from 15% to 30%.

Morris said Defense spends about $1.2 billion on aeronautical spare parts each year. About 7,500 of the 300,000 different line items purchased account for 70% to 75% of all the dollars spent for these spares. Morris said Defense is studying which of these 7,500 items can be bought by competitive bidding. The new policy for buying spares will be partially in operation by Jan. 1, he said. Another change will be to keep closer track of the supply of aeronautical spares so they can be purchased through competitive bidding, rather than reordered automatically from the previous supplier.

RL-10 Engine Passes Preliminary Testing

Washington—Pratt & Whitney RL-10 hydrogen-fueled engine has successfully completed its preliminary flight rating test in a five-day series of 20 demonstration firings at the firm's Florida development center in West Palm Beach.

Success of the test indicates that the engine has overcome its serious development problems which have delayed the Atlas-Centaur program a year beyond its original schedule (AW Oct. 23, p. 22). A cluster of two RL-10 engines will power the General Dynamics/Astronautics Centaur stage, which is scheduled to be flight tested in January.

A cluster of six RL-10 engines also will make up the second stage of the Saturn C-1 configuration, and a live two-stage Saturn will be test flown in the fifth Saturn development launch (AW Nov. 6, p. 30).

Pratt & Whitney and the National Aeronautics and Space Administration have standardized the engine designation as RL-10. Previously, it was called LR-115. The company said that during the test, the engine consistently produced its rated 15,000 lb. thrust. Theoretically, the high energy hydrogen-oxygen propellant combination has a specific impulse approaching 400 sec.

Pratt & Whitney has delivered 12 engines for further testing to USAF Systems Command's Edwards Rocket Test Facility, NASA's Lewis Research Center, General Dynamics/Astronautics and Douglas, which will build the Saturn RL-10 stage.

During the development program, the engine was static fired more than 700 times, with total firing time of more than 60,000 sec. Current static firings average 70 each month at West Palm Beach.

Radioisotopic Fuel

Radioisotopic fuel capsules containing small amounts of plutonium 239 are being subjected to extreme heat at the Atomic Energy Commission's Nevada test site in experiments to gather data for the design of isotope power units which can survive launch pad accidents, withstand impacts and burn up during re-entry of the atmosphere. Experiments will also determine behavior of nuclear material which might be released in the atmosphere in the event of melting (AW Aug. 7, p. 35). They are being conducted by General Dynamics/Ft. Worth under an Air Force contract. The capsules were made by the Martin Co.'s Nuclear Division and loaded with plutonium 239 at the AEC's Mound Laboratory, Miamisburg, Ohio.

Defense Assuming Right to License Communications Satellite Devices

By Katherine Johnsen

Washington—Defense Department—at the direction of the White House—is assuming the right to license to private organizations all developments under programs related to communications satellites, including the Army's comprehensive Advent program.

A provision patterned after the patent provisions included in contracts of National Aeronautics and Space Administration, and specifically after the so-called "no rights" provision of the NASA contract with American Telephone & Telegraph Co. for development of a communications satellite, will be included in all existing as well as future Defense Department contracts which, "with reasonable imagination," have a relation to communications satellites. This includes boosters, and probably propellants, although the demarcation line has not been firmly drawn.

Army's Signal Corps already is including the provision in two new Advent contracts now being negotiated. Service contracting officers last week received written instructions from the Office of the Secretary of Defense on the inclusion of the provision in all existing and future contracts. Prime contractors will be required to include the provision in all subcontracts.

The main objective of the move is to assure that if the Administration decides in favor of a private organization to establish, own and operate a world-wide commercial space communications system, all technological developments will be at its command.

The new licensing provision will place the government in a position to turn over all the technological know-how for use by the new private organization. In his policy statement (AW July 31, p. 25), the President said that "private ownership and operation of the U. S. portion of the system is favored" provided that numerous public interest requirements are met.

The move is also being interpreted as a first and major step in bringing Defense Department's patent policy, which grants industry exclusive commercial and foreign licensing rights, into line with those of NASA, Atomic Energy Commission, and other government agencies, which now retain by law the rights for private licensing.

Members of Congress who favor government retention of all patent rights on all inventions under government contracts, and have ineffectively fought Defense's policy for years, have recently used the communications satellite program in an effort to push their case.

At hearings of the Senate Small Business Monopoly Subcommittee last August, Chairman Russell Long (D.-La.) singled out Army's Advent contract with the Bendix Corp. as an instance in which a corporation, because of its exclusive commercial patent rights, could block development of the communications satellite system—or dictate terms to its private management (AW Aug. 7, p. 26).

Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, told AVIATION WEEK that the fact that Defense at this point is restricting its new patent policy to the space communications field "does not mean that it will not be extended to the entire space field."

Welsh sees no significant difference between the new Defense patent provision and the provision in the AT&T-NASA contract. Under the latter, NASA would have commercial rights to all AT&T inventions, while under the new Defense provision, the department reserves the rights only to those inventions related to the communications satellite field. As a practical proposition, however, if AT&T were to develop a new process for soap manufacture, for example, the space agency would waive its rights, according to Welsh.

A Defense Department spokesman reported "some signs of unwillingness on the part of industry" to accept the new licensing provision, but said: "We are in the driver's seat. Contracts in which it is not included can be cut off."

The new provision states that in addition to the patent license to the government, the contractor grants the government "the right to grant sublicenses to others . . . for the practice of any subject invention throughout the world in the design, development, manufacture, operation, maintenance and testing of communications satellite systems, and of equipment, components, ground tracking, transmitting and receiving facilities. . . ."

Comsat Plan Is Backed by Firm

Washington—General Telephone & Electronics Corp. last week endorsed the plan for development and operation of a commercial communications satellite system by a non-profit company composed of users of the system—providing that GT&E be permitted to participate in the company at the outset.

In a brief filed with the Federal Communications Commission, GT&E said it is prepared to make an initial investment of "at least $500,000" in the company and wants the opportunity to make later additional investments. GT&E's brief was the only one received by the FCC by late last week.

GT&E had vigorously protested exclusion from the ad hoc committee of 10 international common carriers, appointed by the FCC, which drew up the plan.

In its brief, GT&E said that "on the whole . . . the plan of organization and operation proposed by the committee, with but slight modification, provides a basis upon which the development of an operable commercial communications satellite system may proceed without the need for government subsidy or government operation."

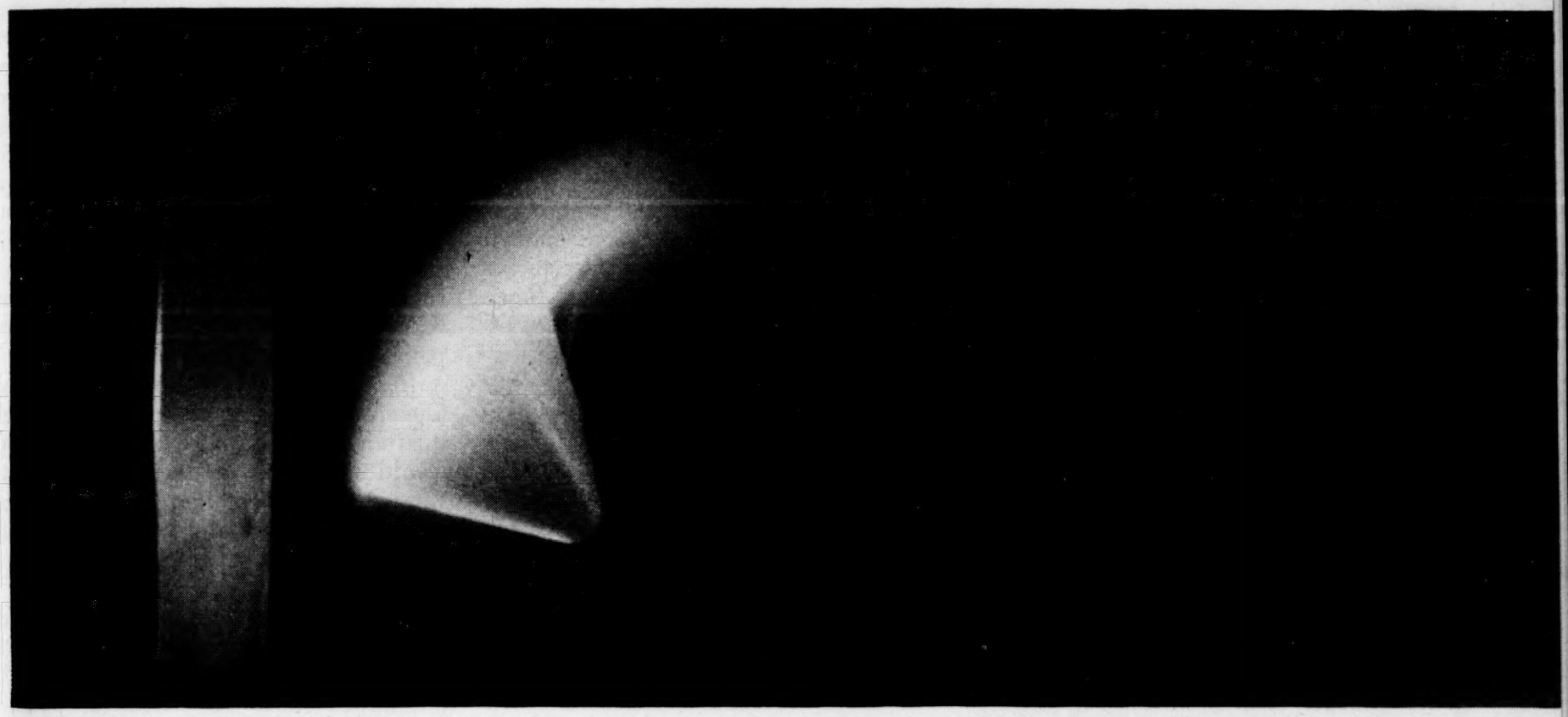
Although less skeptical than Administration witnesses in testimony before the Senate monopoly subcommittee headed by Sen. Russell Long (D.-La.) (AW Nov. 13, p. 26), GT&E noted that "implementation of the plan . . . would involve the resolution of numerous technological, regulatory, economic and operational matters on which the report sheds no light."

Under the ad hoc committee plan (AW Oct. 23, p. 28), carriers certified by FCC to use the satellite system, and which make an investment of $500,000 or more in the non-profit company, would have two members on the board of directors. In addition, there would be three public directors appointed by the President, and carriers using the system but not investing in it would be entitled collectively to one director.

Companies prepared to make the $500,000 or more investment are: American Telephone & Telegraph Co.; International Telephone and Telegraph Co. through its two affiliates, American Cable & Radio Corp. and Radio Corp. of Puerto Rico; Hawaiian Telephone Co.; and possibly Western Union Telegraph Co. and RCA.

GT&E supported the minority proposal of Western Union that the ownership of ground stations—as well as satellites—be placed under the same management. "Individual ownership of the ground stations would be costly, may be wasteful of frequency spectrum and may create interference and operational problems which far outweigh the supposed benefits to be derived," GT&E said.

GT&E rejected Western Union's proposal that the satellite system be developed and operated by a public stock corporation, with ownership open to all carriers, aerospace companies, equipment manufacturers and the public.



IN IONIZED AIR FLOW of 35,000 fps., a 2.5-in. dia. model spacecraft, mounted at a small angle of attack, glows white-hot in a shock tube tunnel at General Electric's Missile and Space Vehicle Dept. The tunnel, modified by the addition of a 10-in. dia. nozzle to the end of the tube, is used for radiative heat transfer tests. Smaller models were placed inside the tube for convective heat transfer tests and GE/MSVD found that heating loads on re-entering spacecraft, traveling at superorbital speeds, will be 2.5 times greater than had been estimated previously because of the ionization of the air. Note aerodynamic tab (top) on the model.

GE Tests Raise Estimates of Heat Space Vehicles Face in Re-entry

Philadelphia—Shock tube tests of air, ionized at flow velocities of up to 40,000 fps. at simulated altitudes of 10 to 20 mi., have indicated that manned space vehicles—such as Apollo—traveling at superorbital speeds may encounter convective heating loads 2.5 times greater than had been estimated previously.

Tests, conducted by General Electric's Missile and Space Vehicle Dept. with company funds to verify a theory developed under contract from the National Aeronautics and Space Administration, showed that as the flight speed of a vehicle increases during re-entry, there is a rapid rise in both the ionized content of a given volume of air flowing over the vehicle and the thermal conductivity of this ionized component.

GE/MSVD has found that where the ionized component of air flowing over a ballistic missile nose cone is less than 1.0%, hypervelocity flight increases this figure to about 13%.

Two GE/MSVD scientists, Dr. Sinclair M. Scala, who did the theoretical study, and Dr. Walter R. Warren, who conducted the shock tube tests, said that convective heat transfer rates—the heat transferred to the surface of a body from the boundary layer of a hot gas—will be considerably higher than had been estimated from the extrapolation of nose cone data.

Gas temperatures in excess of 20,000F can be expected, Scala and Warren said, in such a highly ionized, high-velocity air flow and perhaps peak at 50,000F under non-equilibrium conditions. Spacecraft surface temperatures probably will exceed 4,000F, they said.

Radiative heat transfer rates—the heat induced in an object by the emissive energy of a hot gas flowing over it—also will be higher than previous estimates, Scala and Warren said. GE/MSVD now has a research program under way, similar to that recently conducted for convective heating, to determine the extent of radiative heating in highly-ionized air.

The GE scientists said that this newly-discovered heating effect of ionized air undoubtedly would have to be incorporated in the design of any manned spacecraft. Where convective heating drops as the nose radius of a vehicle increases—by spreading the heat over a larger area—radiative heating increases in direct proportion to larger frontal cross sections.

Optimum spacecraft configuration, they said, would have to be a compromise between a design that is effective against convective heating and one that can withstand radiative heating. Unlike vehicles moving at lower re-entry speeds, Scala and Warren said, where convective heating accounts for about 90% of the heat transfer, a vehicle moving at superorbital velocities—about 25,000 mph.—will have to contend with both high convective and radiative heat loads.

The GE scientists said there were several possible approaches to this design problem:

- **Ablative cap over a re-radiating shield** with the former burning off under the initial high and short-duration heat loads and the latter sustaining the vehicle at lower temperatures over comparatively longer periods.
- **Development of a new material** that would both absorb and re-radiate heat over the entire heat-flux curve. The material could be either a plastic or a refractory metal and GE is presently investigating several such materials.

Shock tube tests were conducted in a 2-in. dia., 11.5-ft. long tunnel which could accommodate 0.75-in. dia. models. Test durations averaged about 13 microseconds.

Scala, using an International Business Machines Corp. 7090 computer, constructed a theoretical model of an ionized air flow to determine the temperature profile, velocity, distribution and composition of gas particles within a plasma sheath. These physical variables were all computed on the 7090, using a simultaneous set of non-linear differential equations, and Scala finally calculated heat transfer rates (Btu/ft.^{2}/sec.) of ionized air flows over a wide range of altitudes and velocities. These values were then compared with the convective heating rates imposed on the models in tests and, according to the two GE scientists, good correlation was achieved between the two.

AEC, Air Force Facing Showdown On Development, Control of Spur

Atomic Energy Commission and the Air Force are heading for a showdown over which will run the Spur (Space Power Unit Reactor) program, possibly with development contracts for the system staked on the result.

Limited AEC funding is expected by the first of the year for the reactor, the pacing item in the Spur program. The Atomic Energy Act makes it illegal for development of the reactor to begin without AEC funds and supervision, and AEC may want to assign this development to Pratt & Whitney Aircraft rather than to Aerojet-General's Nucleonics Division, which is subcontractor on present USAF study contracts (AW Sept. 4, p. 56; Oct. 30, p. 29).

Pratt & Whitney is performing high temperature reactor work under AEC contract. Air Force funding of Pratt & Whitney's indirect cycle nuclear aircraft engine was dropped by the Kennedy Administration earlier this year. AEC may be interested in developing the Spur reactor to higher power levels than planned by USAF.

To date, Spur has been conducted as a study program but that phase of it is about ended and little more can be accomplished without starting full-scale development work.

Study contract team is headed by AiResearch Division of Garrett Corp. as prime contractor with the responsibility for system dynamics including turbomachinery, pumps, radiator-condensers, and boilers. Other main subcontractors are Westinghouse Electric Corp. studying a. c. generator design and Battelle Memorial Institute studying fuel and materials.

Original program planning anticipated that after completion of the study phase, the program would be split into coordinated parallel development of the dynamic systems under Air Force contracts and the reactor under AEC contracts. The two programs would then be reunited when components are integrated in space vehicles.

Members of the study contract team are concerned that when AEC steps into the program, other system elements, perhaps the entire program, will be assigned to Pratt & Whitney instead of Aerojet. They believe Aerojet has established a good selling point in the study phase but fear the AEC may try to capitalize on the existing investment in Pratt & Whitney.

Engineers argue that there would be no advantage in scheduling or costs since neither company has actually built a uranium carbide-fueled, fast reactor of the type planned for Spur.

Two or three years of full-scale development will be needed before enough is known about the Spur system to begin detailed mission planning. Since the Saturn booster system will be available by 1965, Spur contractors are urging that a start be made on the big 300-350 kw. space power system to introduce it in service as soon after that as possible. Under present program planning, with hypothetical funding levels, Spur could not be ready for service before late 1968 or early 1969 even if full scale development began immediately. To meet that delivery date after a delayed start will call for funding levels much higher than those hypothesized.

If AEC does take a positive step to support the program before the end of the year, company officials agree it would probably be of limited scope. They believe new obligational authority in the next fiscal year will be needed to maintain planned schedules.

LTV $13-Million Loss Caused by Writeoffs

Dallas, Tex.—Loss of $13,328,000 on sales of $43,725,000 has been recorded by Ling-Temco-Vought, Inc., for the third quarter ended Sept. 30, after providing for writeoffs of $13,039,000.

Large writeoff was attributed by company's officers to development of compatible management and operating practices and policies for LTV following the combination of Chance Vought and Ling-Temco and the decision to make this adjustment in third quarter, with the result that no further unusual writeoffs are expected in the fourth quarter. An improving profit trend is expected in 1962 and thereafter.

Third-quarter writeoffs included:

- **Initial** development costs, tooling and start-up costs of new products.
- **Accumulated** research and development costs.
- **Re-statement** of inventory values to reflect anticipated losses on certain production contracts.
- **Establishing** a reserve necessary for possible future losses on sale or disposition of assets.
- **Expenses** incurred in defense of legal action by the Justice Dept. attempting to restrain the merger of Chance Vought and Ling-Temco.

Net operating loss of $12.5 million was also reported by LTV for the nine months period on sales of $114,572,000 compared with earnings of $2,699,000 on sales of $134,531,000 for the same period in 1960. The 1961 operating results include Chance Vought and subsidiaries for the month of September only, and the 1960 results are based on the same comparison. Of this loss, some $1.7 million will be applied against prior years' taxable earnings, generating a cash refund of $800,000 on taxes paid in this period. In addition, this leaves LTV with a loss carryforward of $10.9 million available for reducing future tax liabilities, the company noted.

In another report to stockholders, General Dynamics Corp. said that third-quarter gross earnings of $13,684,000 would not be shown as profit or loss because that amount had been set aside as a partial provision for "anticipated additional losses" in the firm's jet transport program.

Board Chairman Frank Pace, Jr., said that the company's commercial jet transport problems still are not resolved, but added that "our technical people are working aggressively to complete the speed improvement program of the Convair 990."

New X-15 Windshield To Be Flight-Tested

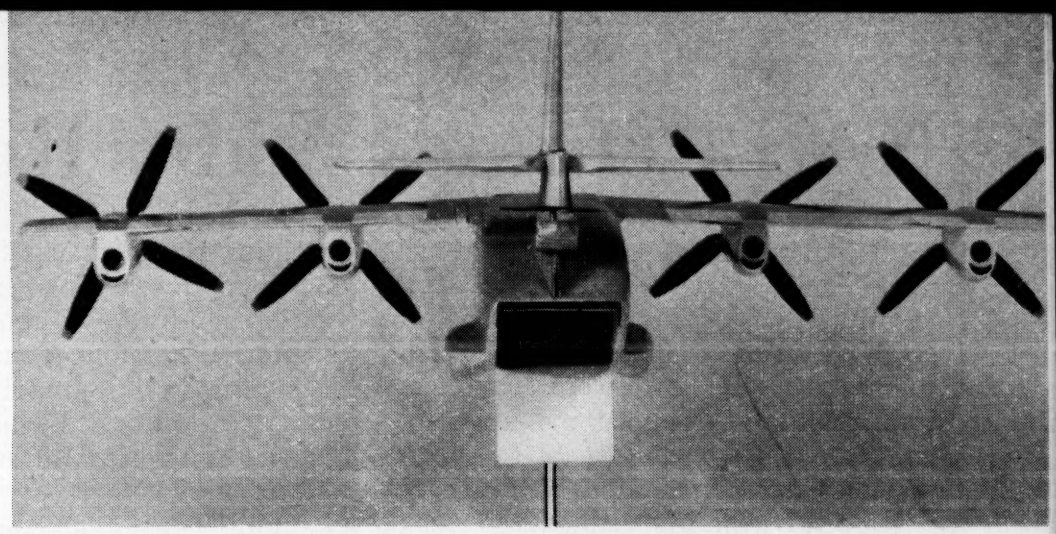
North American X-15 rocket research plane is tentatively scheduled to make its first flight this week with a new windshield modified to prevent shattering under thermal stress.

Specially designed double-pane windshield has shattered on two previous flights by USAF Maj. Robert M. White, one of which was his speed record flight of 4,093 mph. Paul F. Bikle, chief of the NASA Flight Research Center at Edwards AFB, attributed the shattering to bolt stress produced by the different cooling rates of the window and its metal frame after the aerodynamic heating of re-entry. The modified windshield will have expansion joints around the edges of the panels.

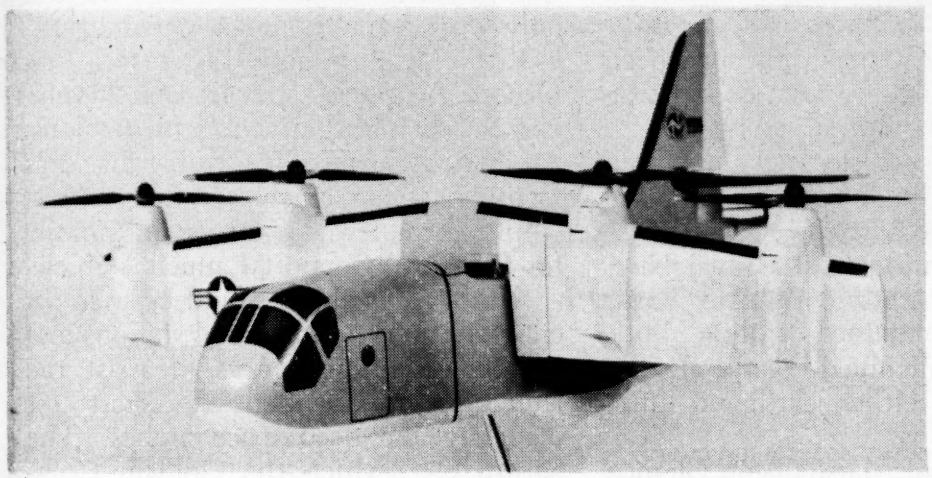
The shattered windshields have never disintegrated in flight to expose the pilot to the impact of ram air at high speed. The left windshield panel shattered in the first incident and the right one shattered in the second (AW Nov. 13, p. 33). If both were to shatter in the same flight the pilot probably would not have enough visibility to land and would have to eject. The test of the modified panels will be made by NASA Test Pilot Joseph A. Walker.

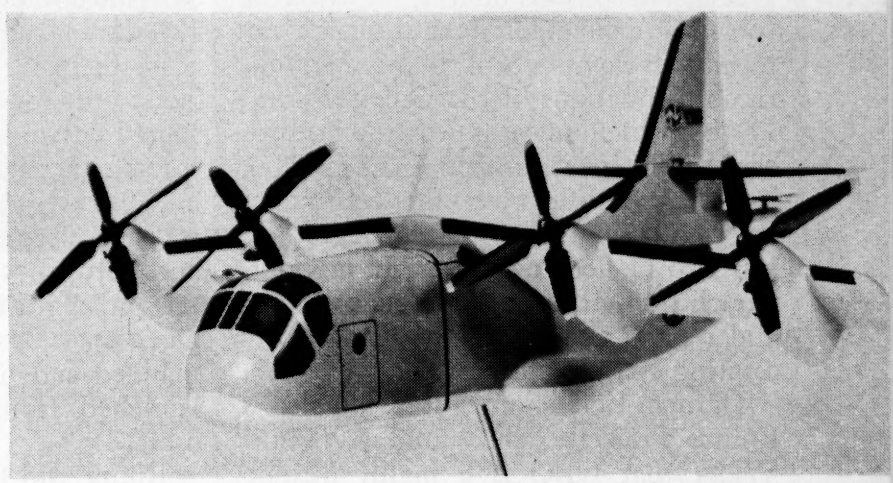
In White's speed record flight, the maximum speed was reached at an altitude of 95,800 ft. Mach number was 6.04. The top altitude reached was 101,600 ft. The windshield cracked somewhere between 60,000 ft. and 70,000 ft. after the maximum stresses of re-entry were already past. (See p. 52 for details on the over-all X-15 program.)

Tri-Service VTOL Transport Photos Show Design Details

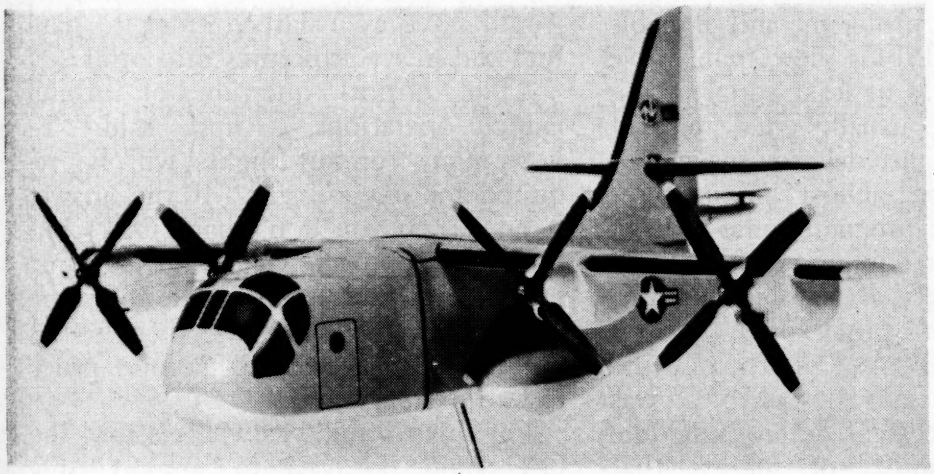


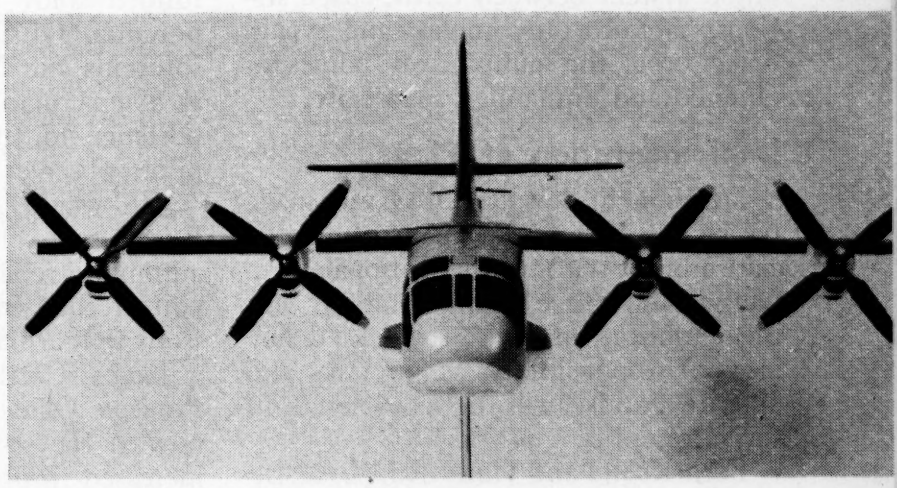
Ling-Temco-Vought/Ryan/Hiller tri-service VTOL transport, shown in above photo, has straight-in loading.



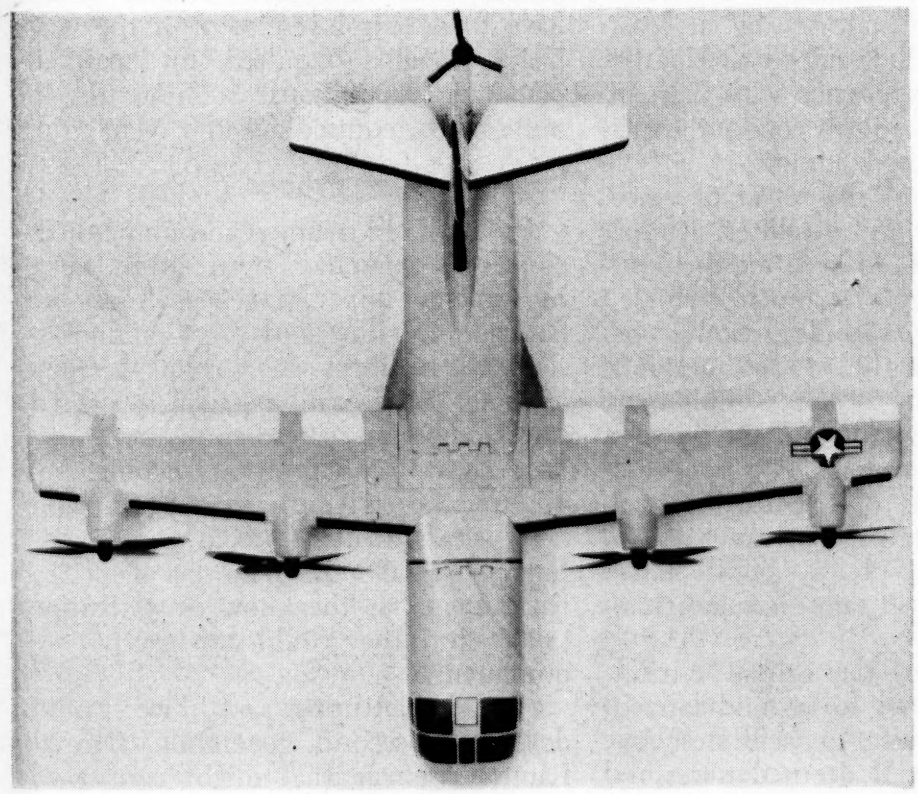


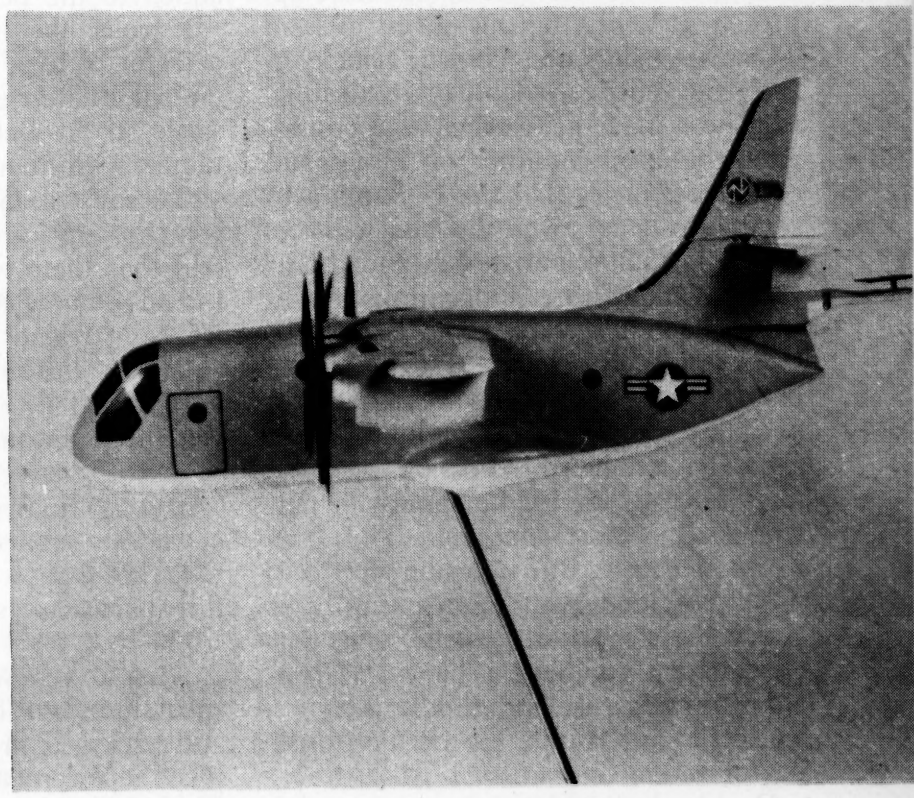
Wing of tri-service VTOL transport will be 67 ft. 6 in. long and will rotate through 100 deg. for vertical takeoffs (AW Sept. 25, p. 352).





General Electric T64-GE-6s are mounted below wing to reduce need for wing structural cutouts and cross-geared for engine-out safety.





Propellers, including 8-ft. tail rotor, will be built by Hiller. Rotor provides longitudinal control in hovering state. Note folding fin.

NASA Studies Wider Rendezvous Concept

By George Alexander

Huntsville, Ala.—Broad concept of space operations that would make maximum use of the rendezvous technique for a multitude of operational and support missions, including the Apollo manned lunar landing flight, is being developed by the Marshall Space Flight Center here.

The concept is called Orbital Launch Operations (OLO) and it is expected to get strong support because it is a detailed development of the rendezvous recommendations of the Golovin Committee, which suggests this method for the Apollo lunar mission (AW Nov. 6, p. 26). OLO involves the techniques and economics not only of rendezvous, but also of docking, assembly in orbit, launch from orbit, in-space maintenance and repair, refueling, and permanently orbiting space stations.

Herman Koelle, director of Marshall's Future Projects Office, told AVIATION WEEK that OLO is a highly flexible system that would establish a transportation system between earth, space stations, satellites and moon, and would make orbit the jumping-off point for manned and unmanned spacecraft.

Implementation of Plans

Decision to develop OLO was made by Dr. Robert C. Seamans, Jr., associate administrator of the National Aeronautics and Space Administration. Implementation of plans which define areas of responsibility, assign tasks and allocate funds, will be completed in several months.

Both Koelle and Harry Ruppe, assistant director of the Future Projects Office, said that the direct, one-shot approach of achieving any given mission —that is, using one launch vehicle to carry one entire payload to its destination—was inadequate when one considered the great number of heavy and complex vehicles that the U. S. plans to send into space over the next decade. Both Marshall scientists contended that OLO is mandatory if maximum use is to be made of resources and money.

"A six-man vehicle to explore the planet Mars would require a payload of about 2 million lb. in orbit," Koelle said. To achieve this mission with the one-shot approach, he pointed out, would require a launch vehicle of "tremendous size." But by using the techniques of rendezvous and assembly of the vehicle in orbit, Koelle said that the mission could be achieved at considerably less cost and time.

Koelle and Ruppe see OLO consisting of several modes:

- **Docking,** where two or more self-sustaining stages or parts of a station are placed in orbit by separate launch vehicles, rendezvoused and then joined to form a complete vehicle. For vehicles that would propel a spacecraft on a deep probe, it would be but a relatively simple task of assembling the self-sustaining units.
- **Fueling,** where empty stages would be placed in orbit and there fueled by a tanker.
- **Maintenance, repair and checkout,** where man will begin to perform functions in space that heretofore had been done only on earth by men or by automated equipment in space.
- **Launch,** with vehicles traveling back and forth between the earth and space stations, between stations and satellites and between stations and a lunar base, on an almost routine shuttle basis. Deep-space exploratory probes, both manned and unmanned, would also be launched from either earth or lunar orbit.

Ruppe said that Marshall and Chance Vought Corp., which is conducting a funded study (AW Oct. 2, p. 23) of potential OLO problems and possible solutions for MSFC, view man's role as a repairman as at least equal in importance to the usually cited roles of pilot, observer and decision-maker.

"It would be almost impossible," Ruppe said, "to program some type of automatic repair equipment that could correct the variety of possible malfunctions that a man's mind could."

James Carter, also of the Future Projects Office, said that MSFC was now in the process of determining the increased probability of success that man, rather than automatic equipment, added to the performance of a system. "It looks like it increases by at least a factor of two," he said, "based partly on our limited experience with man in space so far but mostly on our experience with manned aircraft."

To assist man in the repair of space vehicles, stations and satellites, Ruppe said that there would be a requirement for an Orbit Support Launch Vehicle, whose payload capability would be equal to the weight of the heaviest critical part in any system. "This may well be a requirement laid on the designers of future systems," Ruppe said. "After an analysis of the failure rates of various subsystems, we may have to tell the designer: 'Look, don't make this particular unit any heavier than 1,000 lb.'"

Ruppe believes that these critical subsystems will have to be modularized and packaged in kits, to facilitate complete replacement if deemed necessary by the crew.

As for the support launch vehicle itself, Ruppe said that it would have to be "unmanned, capable of automatic rendezvous and extremely reliable, because we won't want to have to repair a repair vehicle." Booster reliability also will have to be high, Ruppe added, because the nature of a malfunction—for example, in the life support system aboard a manned station—might demand prompt and immediate correction and this requirement can be met only with a quick launch capability.

Koelle, Ruppe and Carter feel that OLO will need a series of launch vehicles to accomplish a variety of missions. An Atlas Agena B, or possibly an Atlas Centaur, would be the smallest vehicle employed and would be used primarily for the Orbit Support Launch Vehicle.

Saturn C-1 vehicle would be used for crew rotation from manned stations and to orbit additional crews to assist the launching of manned spacecraft for planetary and deep space probes. The Saturn C-4, which the Golovin Committee has recommended as the vehicle best suited for rendezvous missions would serve as a flatbed truck to haul fuel and heavy structures into orbit.

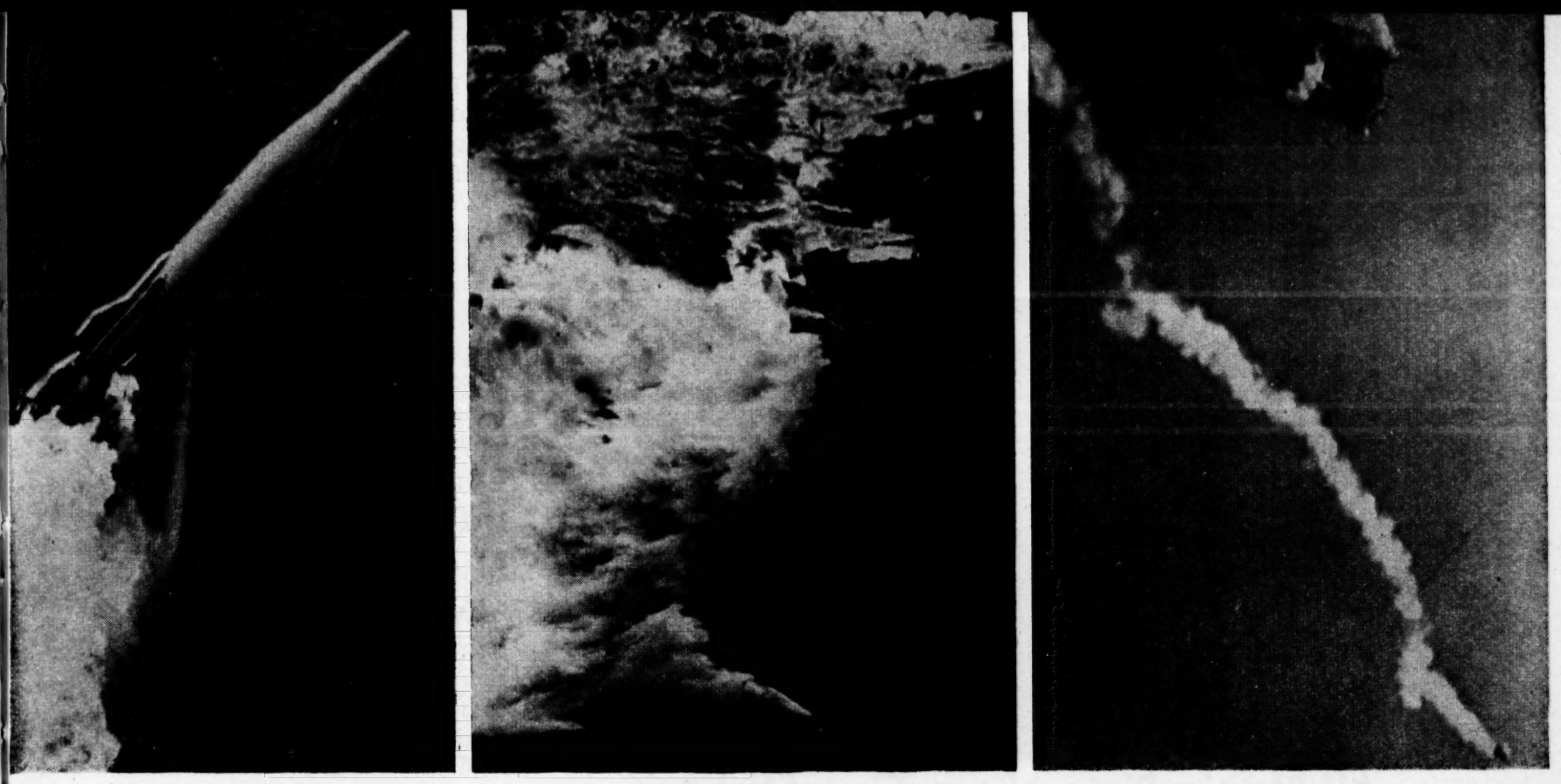
"The critical question of orbital launch operations," Ruppe said, "is: how many support flights will be required for one mission? If the answer is one, then you don't have OLO but the direct approach. The other extreme, say 100, is uneconomical. Somewhere between 2 and 10 flights, then, seems more practical and even five may prove to be the upper limit."

For this reason, MSFC feels that the C-4 could be used to support only Apollo flights (aside from unmanned probes) and that Nova vehicles would have to be employed to orbit the very heavy weights required for manned planetary expeditions, such as the 2 million lb. required for the Mars trip.

Launching of Probes

Probes, both manned and unmanned, could be launched from orbit using high-energy upper stages such as the Saturn S-IV unit and the Centaur assembled to form an Orbital Launch Vehicle. Modifications, such as orbital fuel storage, meteoroid protection, attitude control and position keeping, environmental control, engine restart and crew access areas for repair and maintenance, would have to be made to these stages as they now exist, Ruppe said, before they could satisfy OLO requirements.

"Ideally," Ruppe said, "we would develop a second generation Orbital Launch Vehicle that might consist of spherical tanks that could be mounted



RVX-2A Nose Cone Failure Sequence Shown

Heavily-instrumented RVX-2A nose cone experiment Nov. 10 ended in failure 30 sec. after launch when the Atlas E vehicle went out of control and was destroyed. Photo sequence shows the vehicle starting to pitch over (left), destruction by the range safety officer (center) and debris coming down into the Atlantic Ocean off Cape Canaveral. The 12-ft., 2,800-lb. nose cone, visible in the center picture, was recovered Nov. 12 with the body of the dead experimental squirrel monkey in a 67-lb. environmental canister (AW Nov. 13, p. 25). The 1.25-lb. monkey was part of Project SPURT (small primate unrestrained test), designed to photograph an unrestrained monkey during about 25 min. of weightlessness, and 60 sec. of re-entry with loads up to 52g. Primary purpose of the flight, which was the 100th Atlas launch since testing began June 11, 1957, was to evaluate General Electric and Avco ablative heat shield materials. In addition to the monkey, other experiments were designed to measure the hot plasma sheath and communications effects of the sheath during re-entry, and harmful radiation effects on biological specimens and components during a flight with a peak altitude of 650 mi. and a range of 5,500 mi. Dewar flask on an Atlas pod contained liquid hydrogen, in an experiment designed to determine behavior of the propellant under launch loads. The re-entry vehicle was the 13th in the RVX series and was scheduled to be the last. However, it is expected that additional flights will be scheduled to repeat these experiments, which are considered important to obtain data for extended and high-altitude manned space flights.

on a lattice-type structure. We could eliminate the weight of an airframe and just add that number of tanks necessary to perform the mission."

Koelle likened OLO to a municipal transportation system, with a combination of local and express buses that would link the earth to permanent space stations, space station with space station or satellite, space station with lunar base, or simply joined together in space to form a vehicle for deep space exploration. "This would be in the 1970-75 time span," he said, "when there will be quite a bit of space traffic and an orbital launch facility or orbital support facility will be needed to support it all."

In the most immediate future, the Marshall scientists see OLO being used in the rendezvous and assembly of the Apollo lunar landing mission. There are several ways to do this, they said:

• **Simple assembly** of the manned mission and command module with the lunar propulsion module, each placed in orbit by a Saturn C-4 vehicle. Rendezvous, assembly and launch of the complete vehicle would be accomplished by the crew itself, without any other assistance. If this is the approach taken, MSFC feels that there is a strong possibility that the rendezvous would be performed in lunar—and not earth—orbit, because of the lesser velocities and gravitational forces encountered in the lunar region.

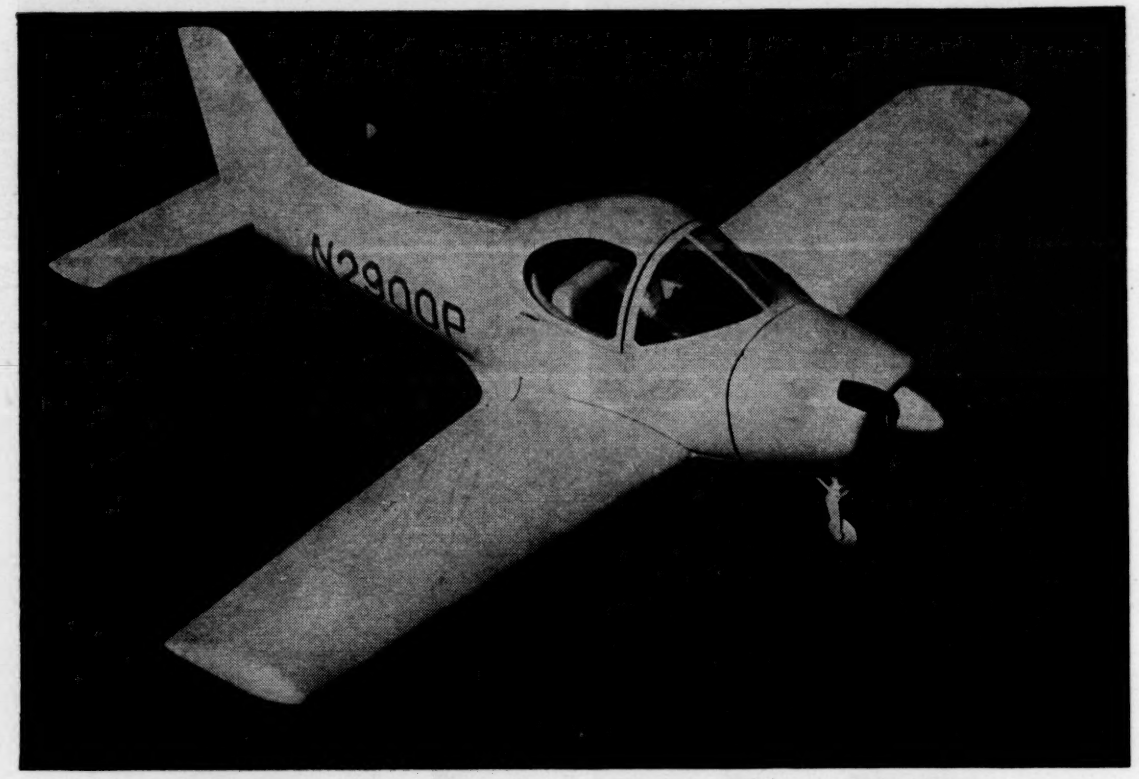
• **Assembly with assistance,** rendered by a second crew in an identical Apollo vehicle. This assist crew would bring the two elements of the lunar landing vehicle together in earth orbit, dock and unite them. The assist crew would also service the lunar landing spacecraft and then return to earth at the time of launch. Koelle and Ruppe believe that assistance will be rendered to take as much strain as possible off the lunar landing crew.

• **Assembly with assistance** at an orbital launch facility, using an orbiting hangar to assemble and checkout the lunar landing spacecraft prior to launch. Construction of such a permanent manned facility in orbit, the Marshall scientists believe, would only add to the complexity of the over-all mission and increase lead times; they therefore consider it unlikely to be developed early enough for use in Apollo's first phases.

A critical part of the rendezvous technique, Koelle, Ruppe and Carter said, is docking two units. "Any transfer of energy, no matter how lightly one section bumps the other," Ruppe said, "will cause orbital perturbations. What we must determine now is the degree of perturbation that we will be able to accept with negligible effect on the spacecraft's orbit." This will influence choice of docking methods.

The MSFC scientists said that OLO would require between $80 and $100 million in Fiscal Year 1962 and between $275 and $300 million in FY 1963 for procurement of operational launch vehicles—such as the Atlas Centaur and the Saturn—testing of components, development of space suits, docking equipment, ground support equipment and an orbital launch facility and orbital launch vehicle. These figures, they emphasized, did not include funds for the research and development phases of either the Saturn or Apollo.

As for earth facilities required to support the OLO system, Ruppe said that the plans that are now being concluded "are trying to live with presently forecast facilities expansion, but we may have to ask for additional launch complexes. We will definitely need some new ground test facilities." Most important facilities would be space simulators of up to 200 ft. in dia. and achieving vacuums of 10^{-8} mm. of mercury.



All-Plastic Piper Nears First Flight

Side-by-side two-place Piper PA-29 Papoose, constructed entirely of molded plastic honeycomb including main landing gear struts, is expected to start flight tests early in 1962 at the company's Vero Beach, Fla., research and development center. Configuration, shown in model form, above, includes "slab"-type horizontal tail, cockpit canopy sliding rearward for entry and exit, one-piece full-span "flaperons" combining ailerons with flaps. Design is aimed at eventually replacing current high-wing fabric and tube steel Colt, uses the same 108-hp. Lycoming engine, but performance is expected to be superior and price lower than Colt's $4,995. Piper states that currently it does not know when the new Papoose will be available to the public.

Satellite Tests Gravity Stabilization

Washington—Use of the earth's gravitational field for stabilization of satellites will be tested by the TRAC (Transit Research and Attitude Control) satellite which was launched into orbit Nov. 15 from Cape Canaveral, Fla., as the piggyback load on the Navy's navigational satellite Transit IV-B.

Orienting one face toward the earth permits concentration of transmitter power in one direction with directional antennas.

Each of the satellites is 43 in. in diameter and weighs about 200 lb. TRAC is doorknob-shaped and will act as a backup for Transit in transmitting navigational information.

TRAC was designed with an asymmetric shape so that its mass distribution would respond to the earth's gravitational field in such a manner that the desired attitude of the satellite would be maintained.

To augment the mass asymmetry, a 60 ft. boom made of beryllium copper 2 in. wide and 0.002 in. thick, whose normal tension causes it to form a tube along its longitudinal axis but is stored rolled along its transverse axis, will be deployed pointing away from the earth after about four days. Until a command is given when TRAC is over a magnetic pole with its desired face pointed toward the earth, the satellite will be stabilized along the earth's magnetic field by two magnets, which will then be switched off.

At the end of the boom is a canister containing an extremely fine diameter coil of beryllium copper embedded in biphenyl which will evaporate gradually, allowing the coil to deploy another 40 to 60 ft. carrying a five pound weight on the end.

The boom itself would be sufficient to orient the desired face of the satellite toward the earth, but pendulum-like oscillations would occur. The weight and spring coil, which furnishes a small amount of friction, is designed to dampen these oscillations.

If the experiment proves successful, the principle could be applied to future satellites requiring stabilization, eliminating the requirement for additional power for orientation devices and increasing the useful life of the packages.

Transit IV-B will continue a number of measurements, augmenting and refining data obtained by Transit IV-A which confirmed that the earth's equator is elliptical, with the longer axis measuring 1,000 ft. more than the short axis (AW Oct. 9, p. 33). Transit IV-B is partially powered by an Atomic Energy Commission-Martin Co. Snap radioisotope nuclear power supply, as was IV-A. Both IV-B and TRAC also have solar cell power systems.

TRAC also contains equipment to measure three types of particles in space: protons, alpha particles and neutrons.

Perigee of the two satellites is 528 naut. mi., apogee is 582 naut. mi., inclination is 32.5 deg. and the orbital period is 105.8 min. Transit was developed by Johns Hopkins University's Applied Physics Laboratory for Navy's Bureau of Weapons. The satellites were launched with a Thor-Able-Star by USAF's Space Systems Division.

Soviets Fail to Attend U.S. Weather Meeting

Washington—Soviet Union has again rejected a U.S. overture for cooperation in space activities by a late refusal to send delegates to a 10-day international weather satellite workshop being held here by the Weather Bureau and NASA.

The Soviet Embassy informed the State Department Nov. 14, the day after the workshop began, that Russian delegates would be unable to attend the workshop. In the same message, USSR requested transcripts of workshop proceedings, which the Weather Bureau said it will forward.

U.S. scientists believed the workshop would be the first government-sponsored space symposium to be attended by Soviet bloc representatives after Russia, Czechoslovakia and Poland formally indicated that they would be represented. Andrei A. Zolotukhin, director of the Soviet Hydro-Meteorological Service, cabled Dr. Francis W. Reichelderfer, U.S. Weather Bureau chief, on Oct. 20 designating three Soviet delegates. They were to be Viktor A. Bugayev, director of the Central Forecasting Institute; Sergey N. Losyakov, of the USSR State Committee on Radio Electronics, and Vladimir D. Maslov, an interpreter and engineer in the Hydro-Meteorological Service.

Visas were requested by the Soviet Embassy for the three, and were granted Nov. 3. The Czech Academy of Sciences informed Dr. Reichelderfer Nov. 7 that Dr. Ladislav Krisky would attend, and the Polish Academy of Sciences wrote Aug. 31 that it would send an undesignated representative. However, neither country followed up by requesting visas.

Soviet bloc delegates at quasi-official scientific meetings have consistently expressed willingness to cooperate in space programs, but this feeling has apparently not yet overcome the political hurdles to government sponsored activities. Unwillingness of Soviet Russia to take part in any international space activities has been consistently demonstrated in its refusal to take seriously a United Nations Conference on the Peaceful Uses of Outer Space.

U.S. Hope is Slim For 1961 Manned Orbit

Washington—Specially-modified Atlas D launch vehicle scheduled to boost the Project Mercury manned orbital capsule was airlifted from San Diego to the Atlantic Missile Range last weekend, but there is only a slim hope that the astronaut orbital mission can be flown before the end of the year.

Manned orbital flight during 1961 has been an important and often-stated target for Project Mercury, but the National Aeronautics and Space Administration will not attempt it until a completely successful three-orbit Mercury profile is flown with a chimpanzee passenger. The chimpanzee flight in Mercury Atlas-5 (MA-5), scheduled for Nov. 14, has been delayed at least until Nov. 28 because of a leak in the hydrogen-peroxide reaction jet feed line.

If MA-5 is successful, MA-6 will be an astronaut flight. If any serious difficulties are encountered, MA-5 will be repeated either with a chimpanzee or without a passenger.

Exhaustive modifications have been made for Project Mercury in the standard Atlas D (AW Sept. 25, p. 96), and the sixth Mercury Atlas vehicle was delivered from the General Dynamics/Astronautics plant to Cape Canaveral in a Douglas C-133B aircraft.

Lack of a second Mercury Atlas launch facility, however, means that erection of the vehicle, mating and checkout of the booster-capsule combination and range checkout for MA-6 must await launch of MA-5. If Pad 14 is undamaged and all systems check out successfully, the MA-6 flight this year is a possibility. During a heavy firing schedule in late 1959 and early 1960, eight Atlas missiles were launched at an average interval of 16 days.

With a Mercury capsule payload, however, the Atlas launch interval has never been less than 63 days.

Two New Commands Proposed for Army

Washington—Army has proposed formation of two new major commands, an increase in size of another command and headquarters staff reduction.

In recommendations to Secretary of Defense Robert S. McNamara, Army Secretary Elvis Stahr, Jr., detailed plans to centralize all research and development—now spread among the Ordnance Corps, Signal Corps, Surgeon General and Transportation Corps—in a Research and Materiel Command.

A Combat Developments Command would combine operational development, planning and doctrine now being performed by the Continental Army Command (Conarc) and the Combat Experimentation Center, Fort Ord.

Conarc, with headquarters at Fort Monroe, Va., will gain many of the training activities now under the technical corps and combat organizations.

The Research and Materiel Command responsibilities would encompass Army activities which, in the Air Force, are split between the Systems Command and Logistics Command. It would include procurement and management of test, R&D, evaluation, supply and logistics for operational systems.

Arab Rocket Launch Controversy

Washington—United Arab Republic last week still had neither confirmed nor denied reports that it has successfully launched its first rocket. The reports have stirred considerable excitement in Arab countries; in Israel, which launched its first rocket last July 5 (AW July 24, p. 65); and in Germany, where the name of Dr. Eugen Saenger of the Stuttgart Jet Propulsion Institute has been linked with the United Arab Republic rocket efforts.

The UAR embassy here said it has not even received replies from the government in Cairo on its queries regarding the reports. But the UAR government radio in Cairo broadcast, without significant comment, a report from a Lebanese newspaper article which indicated that a launching occurred Nov. 8. It referred to "the rocket which the UAR most successfully launched somewhere in Egypt."

Dr. Saenger disclaimed any connection with a UAR rocket program, but said he delivered several lectures in Egypt on the general subject. The Israeli radio, commenting on the reports that Dr. Saenger took part in the program, recalled Nazi Germany's V-2 rockets and said Cairo papers have published photographs of launch preparations and quote from "Dr. Muhammad Mudawwar, head of the missile and rocket center in Egypt," that Egypt could now manufacture missiles and launch them successfully into space.

The Cairo radio in turn has quoted Israeli news dispatches which refer to a UAR "missile" with a range of 186-280 mi., "which means that all Israeli towns will fall within their range."

Israel is believed to have had help from France in its rocket work. The UAR was trying to buy rockets from U.S. firms until the Israeli launching brought this fact to light in July. Then Congress attempted to force State Department to cancel export licenses for such purchases.

News Digest

Amateur radio communications satellite will be flown piggyback on a Discoverer vehicle from Vandenberg AFB next month, the Air Force announced last week. Communications package was assembled by the Project Oscar Assn. (AW Feb. 13 p. 77) from components contributed by a number of avionic firms. Project Oscar satellite will send and receive on the amateur radio two-meter band. If successfully orbited, the satellite will constitute the first civilian, active communications satellite.

U. S. Army termed the launch of a Nike Zeus anti-missile missile from Pt. Mugu, Calif. on Nov. 16 a "100% success." First and second stages of the missile were fired and third stage was inert. Two successful firings were made at White Sands, N. M., Nov. 15.

Discoverer XXXV was successfully launched last week from Vandenberg AFB with payloads intended to furnish more data for the design of payloads in the Discoverer-Midas-Samos family of USAF space vehicles. Recovery was planned for the 17th or 34th orbit.

NASA's Bios I space probe failed when its unguided Argo D-8 four-stage booster rocket veered sharply to the right of course 45 sec. after launch. Another complete back-up rocket and experiment capsule were on hand at Pt. Arguello, Calif. for another attempt.

Lockheed-Georgia Division of Lockheed Aircraft Co. is preparing to open a C-130 Hercules subassembly plant in Clarksburg, W. Va.

Five kiloton atomic device will be exploded underground by the U.S. in Nevada next summer as part of the Vela Uniform program to develop methods of detecting nuclear explosions by measuring seismic waves in the earth. Atomic Energy Commission also announced plans to explode a five kiloton device 1,200 ft. underground Dec. 10 in a rock salt bed to provide a pool of heat for power generation.

American Airlines has asked the Civil Aeronautics Board to suspend and investigate Flying Tiger Line's new cargo rate structure (AW Oct. 2, p. 45), which is based on expected savings from use of CL-44 air freighters. American said the rates would produce too low a return, and said that according to press reports, the rates were based on "the promised economics of an operationally non-existent airplane." (See p. 72 for CL-44 information.)

Critics Push IATA Organization Changes

Small airlines, rebuffed at convention, press bid for stronger voice and an expanded executive committee.

By L. L. Doty

Sydney, Australia—Prospects for changes in the organizational pattern of the International Air Transport Assn. appear to be growing stronger as a result of an intensified drive by small airlines for greater representation within the association.

Although the IATA executive committee successfully rebuffed organizational revisions proposed at the annual general meeting here (AW Oct. 23, p. 33), and easily re-elected its own slate of candidates in a secret ballot, mounting internal criticism of IATA, as it is now constructed, is bringing the need for changes to a head. In addition, the sharp criticism by KLM's V. H. L. Dubourcq (AW Oct. 30, p. 34) of proceedings at the IATA traffic conference, a major function in IATA affairs, brought a significant weakness in the association into the open.

The executive committee anticipated that changes would be proposed and was prepared to deal with demands for a secret ballot, which the dissident airlines hoped would give them representation on the executive committee.

In a private session prior to the general meeting, the executive committee devoted its full attention to balloting because of a fear that the "unpleasant atmosphere" of the Copenhagen meeting (AW Sept. 19, 1960, p. 40) would be recreated. Several proposals were made to stave off the secret ballot, including one that nominations should be submitted 90 days in advance.

Delaying Move

However, it was decided that any such changes would require a revision of bylaws needing approval of the entire delegation. The final decision was to watch the proceedings carefully, and, if a change in voting procedures was forced, propose that the committee study the matter for formal consideration at the Dublin meeting next year.

However, at the close of the private session, Pan American reassured committee members and IATA staff members that the executive committee could retain its strength even in a secret ballot and could guide the voting.

In the election, Richard Jackson, president of Seaboard World Airlines and only representative of the smaller carriers seeking a committee post, mustered but 15 votes out of a possible 60.

Despite the loss, Jackson's supporters felt a victory had been gained by forcing a secret ballot on the meeting. This accomplishment is considered by the group as a major step toward winning more representation at next year's annual meeting which will be in Dublin.

Basically, the smaller carriers want changes in four major areas: executive committee, traffic conferences, enforcement proceedings and IATA management of industry affairs during the long periods between conferences. The group has no desire to oust major carriers from representation on the committee, recognizing that these carriers are major contributors, both financially and in manpower provided for the various conferences. These carriers would like to see size of the committee increased from 18 to 20 members as a means of giving more airlines an opportunity to participate in IATA management. It was noted that all specialized agencies of the United Nations, including the International Civil Aviation Organization, have increased the size of their executive bodies.

The group also suggested that the committee membership include carriers representing all the major geographic areas of the world. Airlines in this category would serve for a term of one year.

Airlines not included in either of these two classes would be given an opportunity to serve one full three-year term. Any vacancy occurring in any of these three groups would be replaced by a carrier in the same category.

It was also suggested that, in view of the fact that traffic conferences are now held once every two years instead of annually, the executive committee should assume greater responsibility in managing traffic and tariff problems. Small carriers held that this could be accomplished with a larger and more representative committee.

They also argued that working groups, serving IATA between conferences, should consist of senior personnel with sufficient authority to make recommendations on major issues that could result in the director general ordering a mail vote. Working groups would be empowered to make policy recommendations to conferences.

Time Monopoly Charged

The small carriers, in calling for changes, echoed Dubourcq's criticism of the traffic conference. They accused large carriers of monopolizing the conference by consuming large amounts of time at the expense of other carriers by dickering among themselves on minor subjects.

This was the heart of Dubourcq's censure of the conference. He warned that "the problem we are faced with is not a matter that lends itself to debate: It cannot be dealt with by a resolution. It is a matter of an attitude of mind, of perspective, of being prepared to sacrifice a short-term interest. . . ."

The small airlines showed special concern over the controversial enforcement issue. Throughout the meeting, fears were expressed that the IATA enforcement system was breaking down, threatening the group's prestige.

Most carriers want stronger emphasis on major violations, less on minor breaches. One proposal called for the appointment of a permanent commissioner in place of the present system of appointing airline officials to serve on a Breaches Commission.

Under this plan, the commissioner would be responsible to the executive committee, with full authority to enforce conference resolutions. It was also recommended that members be required to furnish all records, including corporate reports, on demand as a means of tightening enforcement.

One criticism voiced by several delegates was "a lack of leadership" in the conduct of IATA affairs. The criticism was not necessarily leveled at the director general, Sir William Hildred, who is responsible to the executive committee and serves IATA in its behalf.

Hildred, on occasion, has openly contradicted the private beliefs of many influential members of IATA. For example, he repeated his demands for "low, low" fares despite the fact that many members feel the mounting losses the industry is now experiencing make any further reduction of rates impracticable at this time. Dubourcq, in his report, questioned the wisdom of cutting fares at this time.

Supplemental Air Carriers Passenger Operations

(Civil and Military, 1949-1960)

	Number Accidents			Number Fatalities			Revenue Passenger-Miles (000)	Passenger Fatality Rate Per 100 Million Passenger Miles	U. S. certificated route air carriers all scheduled passenger service passenger fatality rate per 100 million passenger miles
	Total	Fatal	Passg.	Crew	Others	Total			
1949	11	6	104	9	5	118	581,708	17.87	1.04
1950	13	2	29	0	0	29	769,765	3.76	1.34
1951	17	3	78	7	0	85	1,069,497	7.29	1.34
1952	3	1	26	3	0	29	1,251,685	2.07	0.86
1953	13	5	141	20	0	161	1,256,911	11.21	0.46
1954	4	1	9	1	0	10	1,243,030	0.72	0.07
1955	5	2	27	3	1	31	1,395,682	1.93	0.62
1956	0	0	0	0	0	0	1,003,261	0	0.60
1957	2	0	0	0	0	0	767,287	0	0.21
1958	2	0	0	0	0	0	1,152,988	0	0.38
1959	5	1	1	2	0	3	1,589,997	0.06	0.71
1960	3	2	94	8	0	102	2,207,595	4.25	0.75

Notes: Supplemental statistics exclude propeller accidents to persons. Certificated route carrier statistics exclude these accidents as well as homicidal destruction of aircraft by passengers and all non-scheduled operations. Source: Civil Aeronautics Board

Probes to Shape Status of Supplementals

By David H. Hoffman

Washington—Supplemental airlines, their safety record marred by two fatal crashes in the last three months, face sweeping investigations by Congress, Civil Aeronautics Board and Federal Aviation Agency.

Chairman Carl Vinson (D.-Ga.) of the House Armed Services Committee last week named a three-man subcommittee to investigate supplementals and all other airlines contracted to carry military personnel. Rep. Vinson said the investigation, which he hopes will be completed by January when Congress reconvenes, will go beyond recent air crashes and focus on such questions as the Defense Department's method of awarding air transportation contracts and on the "air worthiness" of the equipment used. Members of the subcommittee are: Reps. Porter Hardy, Jr. (D.-Va.), chairman; Daniel B. Brewster (D.-Md.), and James E. Van Zandt (R.-Pa.).

Although the subcommittee will investigate both supplementals and scheduled airlines, the supplementals will have the most at stake because their future status may be decided next year when Congress considers legislation carried over from the last session (AW Sept. 18, p. 45).

The joint CAB-FAA investigation will concentrate on the supplementals safety record, financial status and business practices. CAB Chairman Alan S. Boyd and FAA Administrator N. E. Halaby told each of the 25 U. S. certificated supplemental carriers to send representatives to Washington Dec. 15 to meet with CAB, FAA and "other governmental agencies directly concerned."

In an obvious reference to the Imperial Airlines crash of Nov. 9 which killed 77 persons, the telegram to the supplementals said:

"Recent events and the status of supplemental air carrier legislation have indicated the necessity that both the CAB and the FAA be in a position to assure that all standards of public convenience and necessity are being met and to provide appropriate congressional committees with detailed current information relative to the operation of each supplemental air carrier," Boyd and Halaby said.

The CAB-FAA investigation had been requested by Sen. A. S. Mike Monroney (D.-Okla.), chairman of the Senate's aviation subcommittee, which will review the data collected by the two agencies. John Bell Williams (D.-Miss.), chairman of the House transportation subcommittee, also warned that the results of the CAB-FAA probe may force his committee to re-examine the wisdom of extending the supplemental's operating authority.

A Senate bill passed during the last session of Congress would give the supplementals, which now operate under temporary authority granted by an act of Congress that expires on Mar. 14, 1962, permanent status as certificated carriers. The bill also would enable the supplementals, with CAB approval, to carry individually-ticketed passengers between specified terminals and to fly over scheduled carriers' routes for as long as 90 days during peak traffic periods.

Supplementals generally endorsed the Senate bill while opposing its House counterpart. The House bill, favored by the Air Transport Assn., would restrict somewhat the supplementals' authority to fly individually-ticketed passengers. It also would give CAB authority to decide what constitutes a charter operation, whereas the Senate bill contains a fixed definition of charter flights.

Many airline officials feel that if the Senate bill becomes law, a travel agent could charter an aircraft, schedule it on a package tour and fill it with passengers not representative of any single group. Current CAB rules prohibit this.

House and Senate commerce committee members will meet next year in an attempt to forge a compromise bill acceptable to the whole Congress.

Crash of the Imperial Airlines Lockheed 049 Constellation en route to Ft. Jackson in Columbia, S. C., has sharpened congressional interest in supplemental safety practices and economics and in military airlift procurement policies. The Imperial Constellation, carrying 74 Army recruits and a crew of five, apparently stalled at an altitude of several hundred feet while attempting an unscheduled landing at Richmond, Va., with two of its four engines inoperative and a third losing power. CAB public hearing on the crash will be held in Richmond, Nov. 21.

Only the plane's captain and its flight engineer survived; all others on board died in the wreckage. Preliminary CAB investigation disclosed that most died of burns or suffocated while trying to escape from the Constellation's cabin. The soldiers had been picked up, on an individually ticketed basis, at Newark, N. J., Wilkes-Barre, Pa., and Baltimore, Md., by Imperial.

Investigators subsequently discovered that Imperial, then known as Regina Airlines, was involved in these earlier incidents:

- **Crash at Teterboro Airport, N. J.**, in May, 1950, that resulted in the death of one crew member.
- **Sept., 1953, crash** near Centralia,

Comparison of Operating Results In the Supplemental Airlines Industry

	Revenue Passenger Miles	Cargo Ton Miles	Operating Revenues	Profit (or Loss)
	(000)	(000)	($000)	($000)
1952	1,251,685	78,713	83,249	7,524
1953	1,256,911	75,279	70,028	(1,239)
1954	1,242,224	53,215	54,664	(2,755)
1955	1,395,682	74,601	76,824	4,329
1956	1,004,052	110,376	67,609	452
1957	767,287	86,707	50,454	(2,434)
1958	1,152,988	89,196	65,204	(3,621)
1959	1,589,997	83,106	76,180	(8,997)
Fiscal 1960	2,143,971	73,004	80,955	(4,756)

Wash., that killed 19 soldiers and two crew members.

• **Collapsed landing** gear on two aircraft, one at Aberdeen, S.D., in January, 1954, and one at Charleston, S. C., in February, 1955.

• **Unauthorized departure** in a Curtiss C-46 with 30 Marines on board, which led FAA to fine the carrier $1,000 after it discovered one of the C-46's two engines was short 20 gal. of oil.

Congressional demands for an investigation of supplemental airline operations began to build after the crash of a President Airlines Douglas DC-6 at Shannon, Ireland, on Sept. 10 (AW Oct. 16, p. 45). Accident cost 83 lives.

Thus far this year supplemental airlines have suffered three fatal crashes in which 151 passengers and crew members were killed. In 1960, supplementals experienced two fatal accidents that cost a total of 94 lives. In 1956, 1957 and 1958, they had no fatal accidents, and in 1959, their rate of 0.06 fatalities per 100 million passenger miles was better than the scheduled air carriers' rate of 0.71.

CAB exercises two types of economic control over supplemental airlines. The first stems from the Board's power to award, revoke or withhold the supplementals' operating certificates or exemptions to perform services not authorized by operating certificates. CAB also requires the supplementals to file point-to-point tariffs listing rates charged by each airline between specified city pairs. These tariffs are required for both charter flights and services offering seats to passengers on an individually ticketed basis. The Board's power to pass upon these tariffs is virtually unlimited.

As a general rule, individually ticketed tariffs filed by the supplementals are lower than comparable tariffs quoted by the scheduled air carriers interested in obtaining this type of business. As a result, military transportation officers charged with procuring commercial airlift often contract with supplementals. Military Air Transport Service, under a Defense Department policy directive, cannot engage in extensive personnel movements within continental U. S.

Supplementals often schedule takeoff times to suit the military and frequently don't require advance reservations.

Immediately following the Imperial Airlines accident, at least two of the six Army regional headquarters in continental U. S. ordered their transportation procurement officers to stop moving recruits via supplemental airline. But these directives were quickly rescinded at the Pentagon level by an Army statement that there "has been no change in Army policy regarding the transport of American military personnel from reception to induction centers."

Nevertheless, reliable sources reported last week that Defense Secretary Robert S. McNamara has taken an active personal interest in the restrictions imposed on MATS and in over-all military airlift procurement policies. Staff studies now under way on these subjects could reshape the role of MATS and the supplementals in supporting domestic U. S. troop movements.

In a related development last week, a Douglas DC-4 operated by Zantop Air Transport of Detroit, Mich., crashed and burned while attempting to land at the Greater Cincinnati Airport. Both the pilot and copilot—the only persons on board—walked away from the wreck. Zantop flight, carrying freight for General Motors, had departed Detroit.

Zantop, not a supplemental certificated airline, is authorized to operate by Part 45 of the Civil Air Regulations. As such, it is responsible to FAA but not to CAB, although the Board has repeatedly sought legislation to gain economic control over some 40 Part 45 carriers holding commercial operators' certificates.

Part 45 airlines, also known as contract carriers, may not engage in common carriage of freight or passengers.

GE Sets Fixed Rate For CT-58 Service

New York—General Electric Co. has contracted to maintain, trouble-shoot, overhaul and modify New York Airways' turbine helicopter engines at a fixed rate per engine operating hour, and has signed a similar contract with San Francisco and Oakland Helicopter Airways covering overhaul and modification only.

In New York, General Electric, which manufactures the CT-58 engines used in New York Airways' Boeing-Vertol 107 helicopters, will station maintenance crews and a service engineer at the airline's La Guardia shops to provide line maintenance, trouble-shooting and repair.

The contract calls for service anywhere on New York Airways' routes—if a repair were needed at Idlewild, for example, General Electric personnel would go to Idlewild to attend to it. A small store of parts will be carried at La Guardia.

Overhaul will be done at GE's newly-certificated aircraft service shop at Linden, N. J., and the bulk of the engine parts will be stored there.

The service engineer, a member of GE's installation and service engineering department, will direct and evaluate the maintenance operation at La Guardia.

No GE crews will be stationed at San Francisco, where the airline is operating Sikorsky S-62 equipment.

London Airport Struck By Loaders' Union

London—Official strike by 1,100 loaders at London-Heathrow Airport, a formal protest against a government wage freeze, last week threatened to spread among 27 other unions after severely crippling British European Airways.

With BEA's daily schedules cut in half, and all the airline's 21 Comets grounded, the Transport and General Workers Union was polling other unions, involving 21,000 persons, for support and possible extension of the strike to other airlines.

BEA's loaders are employed by the Ministry of Aviation. They are on strike because loaders employed by British Overseas Airways Corp. received a five-cent hourly wage hike last February. Under an agreement with the Ministry, BOAC pay raises negotiated with the National Joint Council for Civil Air Transport, would have also applied to Ministry employes working on BEA airplanes. However, the wage freeze went into effect last July and Ministry officials said employes could not be raised until the freeze ended.

Northeast Warns CAB of Financial Crisis

By Ward Wright

Washington—Northeast Airlines last week served notice to Civil Aeronautics Board that it will have to ask for subsidy or go to the courts in a bankruptcy proceeding or both unless it gets immediate outside financial help.

Northeast told CAB point-blank that it would have to appear before the Board with Hughes Tool Co., a potential lender, and Atlas Corp., which controls Northeast, no later than Nov. 17 to explain the urgency of its financial plight and begin a complete hearing no later than Nov. 20 if it is to continue to operate.

Earlier, in a letter to CAB dated Oct. 30, Hughes Tool reported that it was willing to give Northeast needed financial aid and asked the Board to take "appropriate action" to make it possible. In the same letter, Hughes Tool notified the Board that it had been discussing with Atlas the possibility of acquiring Atlas' 56% interest in Northeast.

Another letter to CAB filed the same day disclosed that Hughes Tool had been guaranteeing payment to Shell Oil Co. for all of Northeast's fuel and oil delivered since Oct. 20. Shell had notified Northeast that it would have to pay cash for fuel and oil after Oct. 20. Since then, Hughes Tool said it had paid $39,967 for fuel delivered during Oct. 20-27. Northeast owes Shell about $3 million for fuel delivered prior to Oct. 20.

CAB's answer to the Hughes Tool offer, dated Nov. 8, to assist Northeast was that it would waive its established procedure for situations similar to Northeast's by not enforcing the so-called Sherman Doctrine. This is CAB policy applied to cases where control of an airline has been obtained without prior Board approval. The doctrine requires that the applicant for control first divest its control before the Board will hear the case on its merits.

The Board indicated in its answer that, while the Sherman Doctrine might be waived in the case of financial assistance to Northeast, Hughes Tool might still be in violation of the section of the Federal Aviation Act covering mergers, in its discussed acquisition of the Atlas holdings in Northeast.

Also the Board indicated Hughes Tool might be in violation of a provision of an August, 1958 Board order forbidding Howard R. Hughes, controlling stockholder of Hughes Tool, to "cease and desist from acquiring control, in any manner whatsoever" of any air carrier unless prior Board approval is obtained. Board would not commit itself on these possibilities at present.

Other provisions in the Board's answer were to require Hughes Tool and Northeast to file a report by the end of last week listing all agreements, understandings, and transactions between them and all obligations by Howard Hughes or Hughes Tool relative to Northeast or Atlas; and that any agreement between Hughes Tool and Atlas for the control of Northeast be submitted to the Board by Nov. 23 in writing for use in an expedited hearing.

Last week Northeast replied. It asked the Board to clarify its stand on whether Hughes Tool would be placed in jeopardy or subject to penalties for violation of the Federal Aviation Act or Board order if it went ahead with financial assistance to Northeast.

Northeast said Hughes Tool had stated it would be willing to assume the financial risk of backing Northeast but would not assume the legal risk of punitive action if it did so. In view of this, Hughes Tool said it notified Shell Oil on Nov. 10 that it would no longer be responsible for Northeast's fuel bill.

Shell, in turn, notified Northeast that it would require cash for fuel after Nov. 17. Northeast told the Board that the only way it could pay for fuel after that date would be if some of its other creditors would forego their payments. Northeast also told the Board that it feared publicity from the withdrawal of Hughes Tool support might precipitate a demand by creditors for payment of past due obligations. If this should happen, Northeast said it would have to ask for immediate subsidy or start bankruptcy proceedings. Hughes Tool said it would pay the $372,565 fuel bill for the period from Oct. 27 to Nov. 10. Later in the week, Hughes Tool filed a report saying its obligation to Shell for Northeast's fuel bill may total about $600,000 for that period.

Northeast also owes TWA $1 million for leases of Boeing 707s.

The report on transactions among Hughes Tool, Atlas, Northeast disclosed:

• **Northeast owes Hughes Tool** $9.5 million for a loan made under an agreement dated May 14, 1960. The loan matures in three equal installments beginning Sept. 30, 1962, with no provision for acceleration upon non-payment of principal or interest. Northeast is not obliged to make any payment at any time if doing so would jeopardize payment under an agreement which secures its Viscount fleet.

• **Moratorium on payments** had been negotiated between Northeast and its principal creditors—Chase Manhattan Bank, Vickers Aviation, Ltd., General Dynamics Corp., and General Electric Co.—effective last June 30.

• **Aggregate amount** of interest Northeast owed Hughes Tool to Oct. 31—$354,294—has not been paid.

• **Atlas told Hughes Tool** late in August that even with the moratorium on payments, Northeast would not have enough funds to operate until its winter season. Atlas then asked Hughes Tool whether, as a creditor, it would be interested in giving Northeast emergency assistance, and whether it would be interested in acquiring the Atlas holdings in Northeast.

Cost of maintaining Northeast until the end of the year was also discussed. No figure was agreed upon, but brief filed last week said it was estimated to be about $2 million. Hughes Tool indicated it might be willing to put up the money if it could be secured by a second lien on Northeast's piston aircraft, already covered by a lien held by Vickers. Vickers refused.

Current Atlas holdings in Northeast consist of 996,226 shares of common stock—56% of the total shares outstanding, and $16.5 million in 5.5% subordinated promissory notes. Atlas has invested $21 million in Northeast to date, of which $18 million has been since 1956.

Northeast— at the request of CAB—said that Howard Hughes had not taken part in any discussions between Atlas and Northeast.

Carriers Wavering On Fare Increases

Washington — Possibility that Civil Aeronautics Board Chairman Alan S. Boyd's public denunciation of fare increases (AW Nov. 6, p. 37) has dimmed carrier hopes for higher rates grew last week on the basis of several fare actions.

Eastern Air Lines took the unusual approach of asking CAB to approve a fare increase proposal before the airline formally filed its request. Eastern hoped this would save filing expenses if the CAB rejected the tariff. The airline asked increases of 5% to 7% on all service, except first-class jet, Air-Bus and Air-Shuttle. The airline would also drop the family fare plan and eliminate food and beverage service on domestic coach flights.

National Airlines withdrew a tariff which would have raised coach fares to within 85% of first-class fares.

Trans World Airlines filed for a lower one-way piston coach fare between New York and California and proposed to extend its present transcontinental jet excursion fare.

American Airlines decided to retain the family fare plan and drop the controversial youth fare plan and transcontinental excursion fares.

Slim October Traffic Rise Fails To Halt Domestic Airlines' Slump

Washington — Domestic trunkline traffic inched up 2.4% last month, but failed to halt the downward trend of the industry's growth rate, which was 1.2% lower than that of the previous one-year period.

Available seat miles reached a new one-year high of 51.4 billion, a gain of 4.7% over the previous year, while the October mileage of 4.7 billion was 12.7% higher than in October, 1960.

The 29.06 billion revenue passenger miles for the year ending in October, cut the industry's average system load factor from 59.92% for the 1960 period to a new low of 56.54%. In the monthy comparison, load factors dropped from 59.02% for October, 1960, to 53.60%.

Coach Activity Increases

Coach traffic continued to dominate the industry's traffic growth pattern, accounting for 58% of the total revenue passenger miles for October, as compared with 48.8% for the same month last year.

Coach revenue passenger miles showed a gain of 21.7% over October, 1960, and accounted for 1.47 billion of the industry's total 2.53 billion miles. First-class travel was down 1.6% in the monthly comparison.

The four largest operators—American, Eastern, Trans World and United—experienced a 1% drop in revenue passenger miles, on the basis of 20.5% loss in first-class traffic and an 18.9% gain in coach miles. Total available seat miles offered by this group increased 11.4%, with a 34% increase in coach and a 9.8% cut in first-class miles. The ratio of seat capacity to sales gave these airlines a 54.3% load factor, as compared with a 61.6% load factor recorded in October, 1960.

In contrast, the seven smaller trunks showed a 12.4% gain in revenue passenger miles, after a 16.5% increase in available seat miles. Coach traffic was up 31.2% for the month, while first class was down 3.3%. Seat mile capacity was increased 28.9% in coach service and 6.5% in first class. Average load factor for these carriers was 51.7% for the month, as compared with 53.6% for the same month last year.

National Air Lines, which along with Delta and Continental has inaugurated service over new routes recently granted in the Southern Transcontinental Case, had the highest revenue passenger mile gain and the only load factor increase among the trunk carriers. The airline increased available seat miles by 29.1% for the month and recorded a 41.2% gain in revenue passenger miles, with a load factor of 50.2%, as compared with a load factor of only 45.9% in October, 1960.

A 12.8% cut in National's first-class seat capacity, plus a 69.4% increase in coach service, gave the airline a 69.7% gain in coach revenue passenger miles and a 1.9% drop in first-class revenue miles.

Northeast's Statistics

Northeast had a gain of 26.5% in revenue passenger miles, reflecting a 67.8% increase in coach traffic and a 2.2% gain in first class. First-class seat capacity was increased 37.9% and coach 38.7%, producing a load factor of 43.1% for the month. The carrier's load factor for October of last year was 47.2%.

Delta increased available seat miles 27.7% in first class and 19.1% in coach. First-class revenue passenger miles were up 13.9% and coach 25.9% for a combined gain of 18.7%. Load factor produced was 56% compared with 58.6% in October, 1960.

Profit potential among the four largest carriers was virtually non-existent during the month. Three of the airlines barely matched the traffic of last October, while American had a 2.5% drop in revenue passenger miles.

American reduced its first-class capacity 13.3% and increased coach 28.4%. This resulted in a 21.4% gain in coach revenue passenger miles and a 23% drop in first-class revenue miles. The airline's monthly load factor of 55.4% was 10 points below that for October, 1960.

Eastern was the only major trunk to "break even" in terms of revenue passenger miles, which were up a meager 0.7% for the month. First-class capacity was cut 7.2%, while coach was increased 23.1%. The airline's load factor for the month was 44.9% on the basis of a 13% drop in first-class revenue passenger miles and a 12.5% gain in coach traffic.

Greatest Variance

Trans World Airlines' domestic service showed the greatest load factor variance among the major trunks, at 53.3%, as opposed to 64.3% in October of last year.

The airline had a 0.5% revenue passenger mile loss for the period, on the basis of a 25.2% drop in first class and 18.2% gain in coach miles. Total seat mile capacity was up 20%, reflecting a 6.7% drop in first-class available seat miles and an increase of 42.1% in coach miles.

Promotional Fares

New York—Nine North Atlantic airlines, meeting again here recently to thrash out possible promotional fare plans, again were blocked over details of new proposals and recessed without definite decisions.

Pattern of the meeting was somewhat the same as that of a similar session last July in London, which was attended by 17 of the carriers (AW Aug. 7, p. 36). There was general agreement that something should be done but disagreement over exactly what should be done.

Principal plans under discussion were an extended excursion fare and a group fare. Some proposed restrictions on the plans, according to airline sources, were such as to block serious consideration by other carriers. For example, one proposed restriction on any group reduction was that fare would not be refundable later than 30 days before a flight. A proposed 28-day maximum excursion fare reportedly attracted some interest, but a dissenting carrier proposed a 28-day minimum stay in an excursion fare plan.

Further attempts to come to agreement on some form of promotional fare are expected in the near future by the transatlantic carriers. Airlines attending the recent meeting were Alitalia, Air France, BOAC, KLM, Lufthansa, PanAm, SAS, Trans-Canada, and TWA.

KLM Deficit Blamed On Low-Fare Traffic

New York—KLM Royal Dutch Airlines showed a net loss for the third quarter of 1961 of $1.2 million, compared with a net profit of $3.5 million in the third quarter of 1960. Net loss for the first nine months of 1961 was $11.5 million, compared with net earnings of $2.8 million for the same period of 1960.

Operating revenues for third quarter 1961 totaled $49.4 million, down slightly from $50.8 million in the third quarter of 1960. For the nine months, revenues were $128.2 million, up from $122.2 million in same 1960 period.

KLM reports a system increase of 21% in capacity for the nine months and a traffic increase of 12%. Traffic growth, the airline said, was concentrated in lowest passenger fare and freight tariff classes, causing revenues to lag behind traffic gains.

KLM, because of the unfavorable results, has omitted the interim dividend usually declared at this time of year. The nine-month loss amounted to $7.90 per share of common stock. For the nine months of 1961, KLM's depreciation and amortization charges totaled $17.7 million.

Third Quarter Reports Stress Continuing U.S. Carrier Decline

New York—Declining financial results of U.S. airlines generally continued through the third quarter of 1961, during which many carriers reported a decrease in earnings or a greater loss than in the same period of 1960. There were some exceptions.

From early indications, traffic may be picking up in recent weeks compared with the same period of last year.

Despite the third quarter general decline and the disenchantment investors express with airline equities, airline stocks have shown some recovery from lows this fall, indicating a degree of latent interest in them. The interest is speculative, and lacks the support of institutional investors who represent the type of investing that would tend to stabilize airline stocks.

Some sources believe 1962 will show indifferent results, but are much more optimistic for 1963. By then, they feel, the overcapacity situation will be largely resolved. From this point of view, buying now of airline stocks would be expected since prices still are depressed despite the small recovery.

On the other hand, some sources describe the current slight rebound as largely a technical reaction from a few weeks ago when many airline stocks dropped to new lows. Recent buying is thought to be "impatience" buying by investors who feel it is time for an upturn.

Major Exception

A major exception to the third quarter trend was Pan American, with a third quarter net income after taxes of $11,337,000, up from $4,985,000 in the third quarter of 1960. PanAm's nine-month figure in 1961 was $8,749,000, up from $7,317,000 in the first nine months of 1960. Third quarter operating revenues totaled $140,795,000, compared with $119,309,000 for the third quarter of 1960.

PanAm's results were aided by an improvement in the Latin American Division's financial standing. A company spokesman said the division may break even for this year or perhaps earn a small profit, which would be the first in many years. Increased jet service and capacity in the Caribbean and Latin America was cited as a factor in this improvement. Also, substantial MATS traffic, both on scheduled flights and in jet charters, was a major factor in PanAm's operation both on the Atlantic and on the Pacific. Pan American stock has been very active, reflecting market optimism that PanAm may have established firm control on costs.

Here are some other recently reported third quarter and nine months results:

• **United earned** a net of $1,428,000 for the quarter and a gain of $433,000 on aircraft sales, compared with $7,076,000 net earnings and $931,000 from aircraft sales in third-quarter 1960. Results for the first nine months of 1961, which include four months of operation since the merger with Capital, were net earnings of $4,787,000 and aircraft sales gain of $1,569,000. This compares with 1960 like period net earnings of $5,991,000 and gain of $3,720,000. Combined United and Capital revenue passenger mile volumes for the third quarter of 1961 increased only 3.3% over the combined volumes of third quarter 1960. Comparing the combined 1961 operations against only United's in 1960, revenue passenger miles increased 27% for the nine months to 5,500,505,000; operating revenues totaled $370,948,206 for the 1961 nine months compared with $278,893,426 for the nine months of 1960.

• **Eastern showed a net loss**—described as a net charge to earned surplus—of $3,994,000 for the third quarter and $5,008,000 for the nine months. A net loss from operations for the nine months of $10,374,000 was reduced by a special credit of $5,366,000 representing overhaul reserves no longer required. On a comparable basis, net loss from operations for the first nine months of 1960 would have totaled $4,679,000. Operating revenues for the nine months of 1961 totaled $220,691,000, up from $220,125,000 in the like 1960 period. Revenue passenger miles for the period declined from 3.65 billion to 3.59 billion, and load factor for the nine months dropped from 55.03% to 53.2%.

• **Continental reported** a net profit for the third quarter of $340,000, compared with $732,000 in the third quarter of 1960. Operating profit for the quarters respectively was $1,436,000 and $2,360,000. Gross revenues for the third quarter of 1961 totaled $16,433,000, down from $17,009,000 in third quarter 1960. For the first nine months of 1961, revenues totaled $47,280,000 and net income was $882,000. For the like period of 1960, revenues were $45,768,000 and net income was $1,247,000 excluding $200,000 capital gains.

• **American earned a net profit** of $1,334,088 during the third quarter of 1961, down from $4,302,842 in the same quarter of 1960. Revenues for the quarters respectively totaled $109,825,053 and $116,020,250. Net profits including gains from equipment sales totaled $1,688,137 in third quarter 1961 compared with $4,477,726 in third quarter 1960. For the nine months of 1961, revenues totaled $311,681,632, net profit excluding equipment gains was $2,925,061, and net profit including gains was $4,228,229. Comparable figures for the first nine months of 1960 were $321,867,433 revenues, $6,923,961 net excluding gains, and $7,909,105 including gains.

• **National showed a net loss** of $479,430 for the third quarter of 1961—the first quarter of its new fiscal year—compared with a net loss of $2,094,372 for the same quarter of 1960. Revenues for the 1961 quarter totaled $20,123,600, a 34% increase over the previous like quarter. Operating expenses increased only 14%. Depreciation in the 1961 quarter totaled $2,763,676, an increase of $530,000. Cash generated in the 1961 quarter totaled $2,284,000, compared with a cash loss of $340,000 in the previous like quarter. National's results are attributed to three months of operation over its new southern transcontinental routes.

• **Northwest** showed a net of $2,214,074 for third quarter of 1961, an increase of $639,735 over the same period of 1960. Net for the nine months of 1961 was $3,504,061, up from $1,349,510 for the like 1960 period. Operating revenues for the nine months dropped $15,826,439 to $80,387,883, but third quarter 1961 revenues were $34,330,611, about the same as in third quarter 1960. Tight cost control measures reduced total operating expenses to $71,467,721 for the nine months of 1961, down by $20,185,765 from the same period of 1960.

• **Delta** reported net income of $353,711 for the third quarter of 1961, including gain of $265,000 from sale of flight equipment. Comparable figures for third quarter 1960 were net income $351,611 including $262,088 from sale of equipment. For the first nine months of 1961, net earnings were $3,690,000 including $265,000 from equipment sales. Gross operating revenues for the third quarter of 1961 totaled $36,612,184, a 16% increase over the same quarter last year.

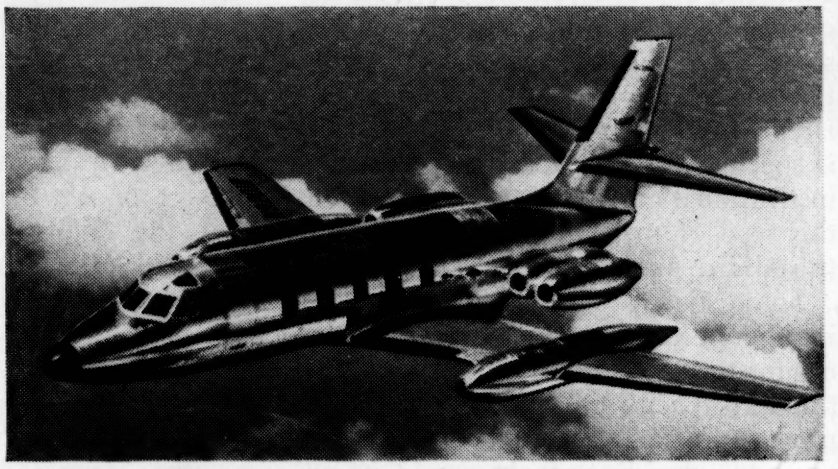
Trunklines' 1961 Loss

For the first nine months of 1961, the 11 U. S. trunk carriers reported a net loss of $16.9 million, compared with net earnings of $5.1 million in the same period last year. Operating revenues for the first three quarters of 1961 were $1,509,037,000 against operating expenses of $1,499,729,000 for an operating profit of $9.3 million. Non-operating expense and income tax brought this figure down to the net loss.

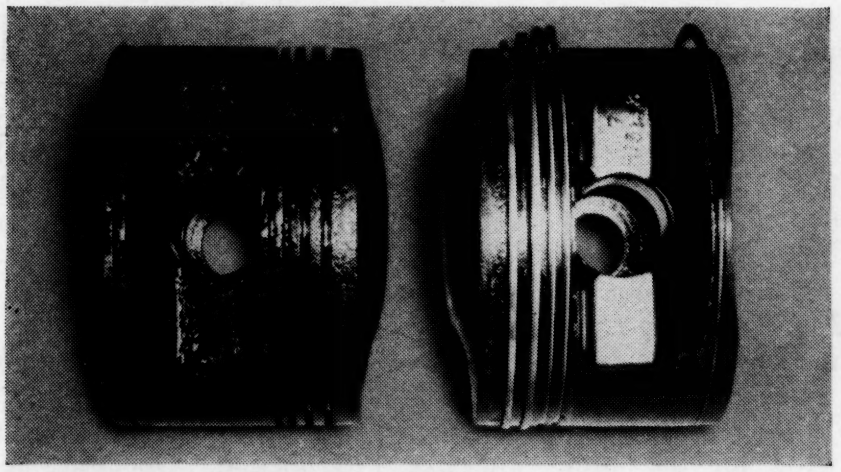
REPORT:

Shell reports on three new lubricants that improve aircraft operation—and two new developments that improve aircraft service

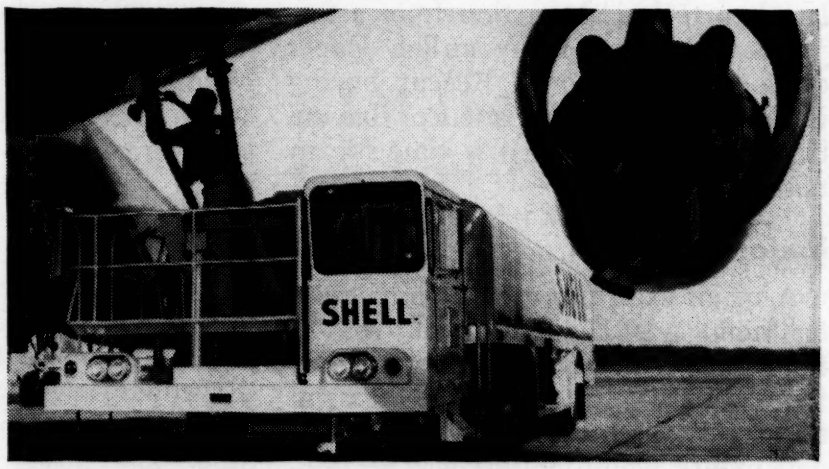
Grease with 700°F. temperature range. AeroShell® Grease 15 is the first grease that lubricates from minus 100° *to plus* 600°F. Made for special applications in jets and missiles. Exceeds military performance requirements.



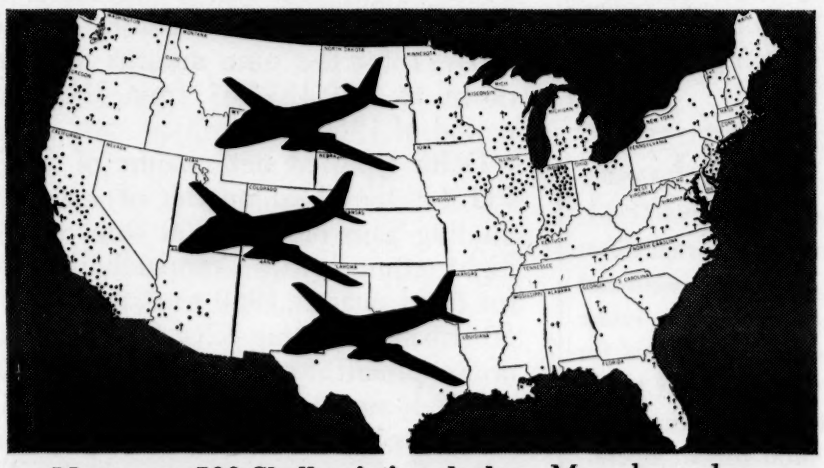
New multi-purpose grease. AeroShell Grease 7A satisfies nearly all the grease requirements of large U. S. jet and piston aircraft. Grease 7A helps ensure correct lubrication, can cut grease inventory as much as 50 per cent.



First non-ash dispersant oil. These pistons were pulled from engines of same aircraft after 1000 hrs. Left piston used straight mineral oil. Piston on the right used AeroShell Oil W. Additives in Oil W are 100% metal free.



Fast refueling. New 8-thousand gallon refueler, built to Shell specifications, can transfer 8,000 gallons of turbine fuel in 13 minutes. Low silhouette permits safe underwing refueling. Cuts refueling time to the bone.



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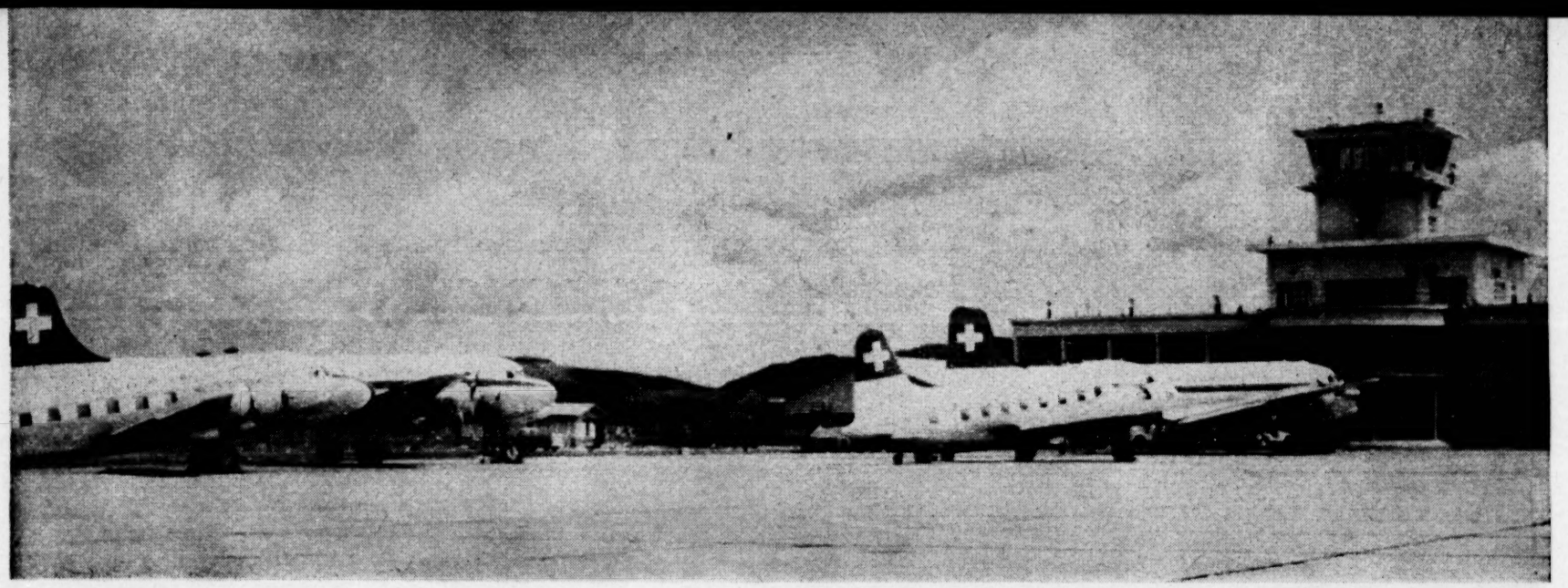


BALAIR VIKINGS AND DC-4s are shown at their temporary Leopoldville base during United Nations' Congo airlift last summer. Two Vikings and two DC-4s made 200 flights totaling about 2,500 hr. in 5½ months carrying food supplies.

Swiss Charter Line Expands Piston Fleet

By Edith Walford

Basle—Balair A. G., 40% Swissair-owned charter company which began nonscheduled passenger and cargo services in June, 1957, is expanding its four-engine piston fleet for increased service to East Africa, Ceylon and the Far East and sees a possible need for jet equipment by 1965.

The company expects delivery by the end of this month of the first of two Douglas DC-6Bs purchased from Swissair. The second probably will enter service by next spring. Following their planned conversion from 80- to 90-passenger configuration, they will be used primarily to accelerate Balair's present long-distance charter flights to East Africa, Ceylon and Tokyo.

The first jet charter services the company hopes to introduce after it has made the necessary equipment purchases will be used for short- to medium-range operation.

In addition to its steadily increasing charter business, Balair's activities include pilot training courses, sightseeing trips, air taxi and crop-dusting assignments. The company also is responsible for the handling and clearance of all foreign charter traffic using Basle-Mulhausen airport.

Financial Struggle

Originally founded in 1925 as a small, privately-owned company with a capital of $25,000, Balair had a hard struggle to survive and was absorbed a few years later by the former Swiss scheduled airline, Ad Astra, now Swissair, with headquarters in Zurich. It took until January, 1953, for the company to re-establish itself as the present Balair A. G. shareholding company with a staff of five and a working capital of $80,000, half of which was privately owned, the other half by the Basle government.

Today, the company's capital is approximately $1 million, and its employes total 210, including 30 flight personnel and 50 technicians.

Present aircraft fleet comprises two 36-seat Vickers Vikings, three 72-seat Douglas DC-4s, three Piper Cubs, one Cessna 180 and one eight-seat de Havilland Dove.

The Vikings with a crew of three—captain, copilot and hostess—are used chiefly for the transport of British tourists between England and Switzerland. They also are used on a considerable number of charter flights carrying soccer teams and other sport and student groups, trade, political and religious delegations to various European centers.

DC-4 Conversion

The DC-4s serve on most of the company's medium- and long-range charter flights. Convertible within two hours from their usual 72-passenger capacity into airfreighters capable of carrying loads up to 9.3 tons, they are used extensively for the transport of urgent cargo, such as perishable goods. A growing number of foreign travel groups also charter Balair DC-4s. Of these, most business is generated between Johannesburg via Switzerland and London, Tokyo and a variety of European centers, and between France and Israel.

On medium-range flights, the DC-4 crew comprises captain, copilot, flight engineer and two hostesses; for long-distance operation, captain, copilot, navigator, flight engineer and two hostesses. The same size crew also will serve on the Douglas DC-6B aircraft this winter.

The Piper Cubs are used for sport pilot training and crop-dusting assignments; the Cessna 180 is used only for sport flying. The de Havilland Dove is used for commercial pilot training, sightseeing trips over the Swiss Alps and air taxi duty, both within Switzerland and to a wide choice of flights available to popular centers of interest throughout Europe. The charge for the round-trip eight-seat Dove flight between Basle and Frankfurt/Main, for example, is $375 and includes a stopover in Frankfurt of not more than 12 hr., with $63 for every 24-hr. additional. The round trip to Paris costs $412, Nice $640 and Vienna $650 from Basle.

Balair has round-the-clock service and can take off on any assignment practically anywhere in the world within two hours after the order is received at its Basle-Mulhausen airport base, according to the company's joint managing director, Otto Gersbach.

In 1959, the two Vikings achieved a total utilization rate of 1,706 hr.; the first two DC-4s, one of which went into service in April, the second in May, 1959, logged 2,188 hr. during the year.

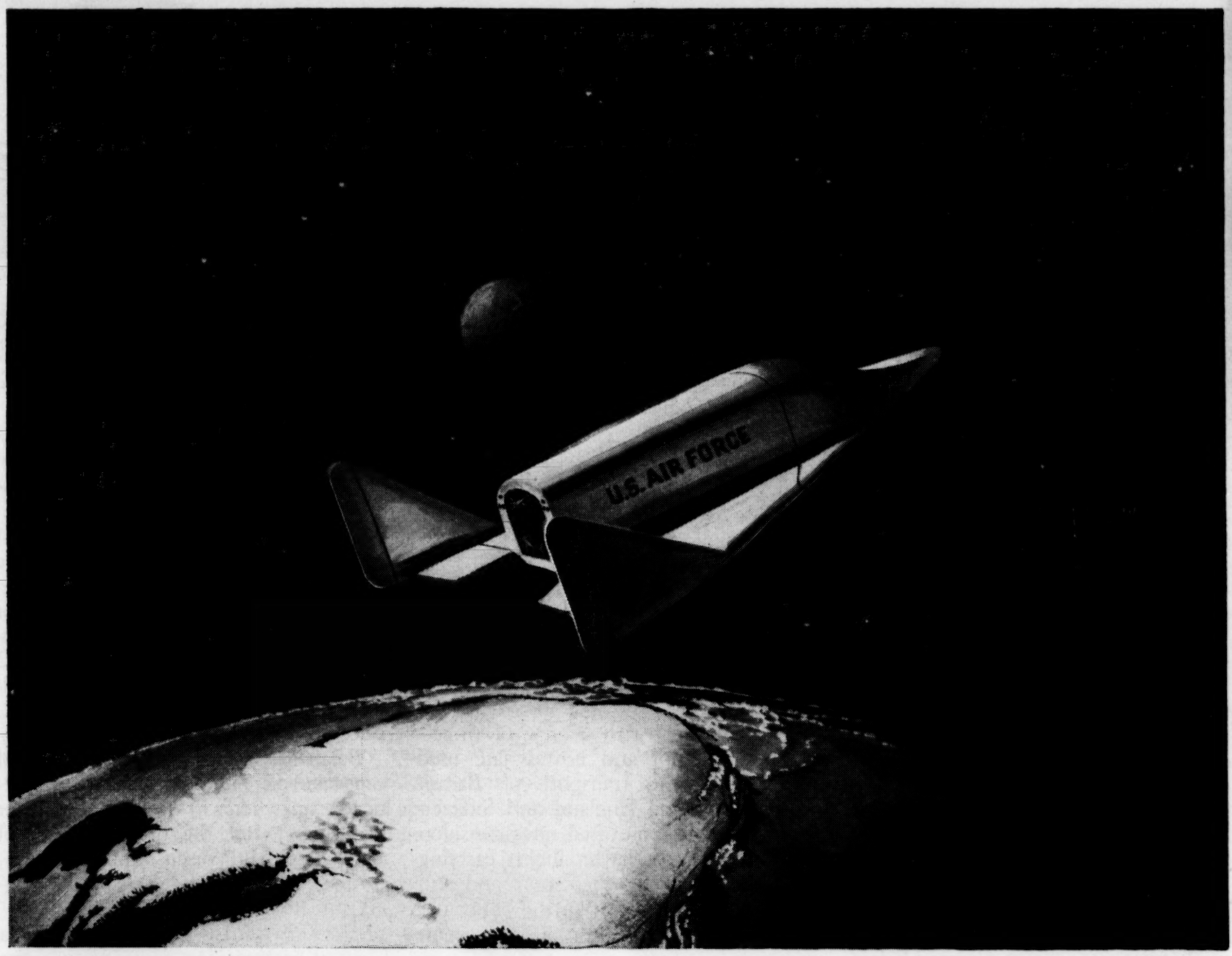
Together the four aircraft carried a total of 37,545 passengers and 34.6 U. S. tons of cargo.

In 1960, total flight hours of the two Vikings amounted to 2,159 hr., while that of the DC-4s, to which a third aircraft purchased from Pan American World Airways was added in June of last year, was 3,909 hr. Total passengers carried numbered 45,080, freight 77.5 U. S. tons.

Third DC-6B Probable

If the present increase in Balair's charter business continues, it probably will take delivery of a third DC-6B from Swissair some time next year. "The aim is to dispose of our two twin-engine, 36-seat Vikings, which have been in service since 1957-58, as soon as possible," Gersbach said. "We figure that with a fleet of three 72-seat, four-engine DC-4s plus the two, or perhaps three, DC-6Bs, we shall be able to fill demand for our charter services until we can introduce our first jets."

Balair's charter business is split about 50-50 between foreign tourists, par-



SPACE GLIDER. Drawing of Dyna-Soar space glider, which will combine extreme speed of a ballistic missile with controlled and accurate flight of a manned aircraft. Designed to be rocketed into space, where it could travel at speeds approaching 18,000 mph, Dyna-Soar will be able to re-enter earth's atmosphere and make conventional pilot-controlled landing. Boeing is system contractor for Dyna-Soar, now being developed by U. S. Air Force with cooperation of National Aeronautics and Space Administration.

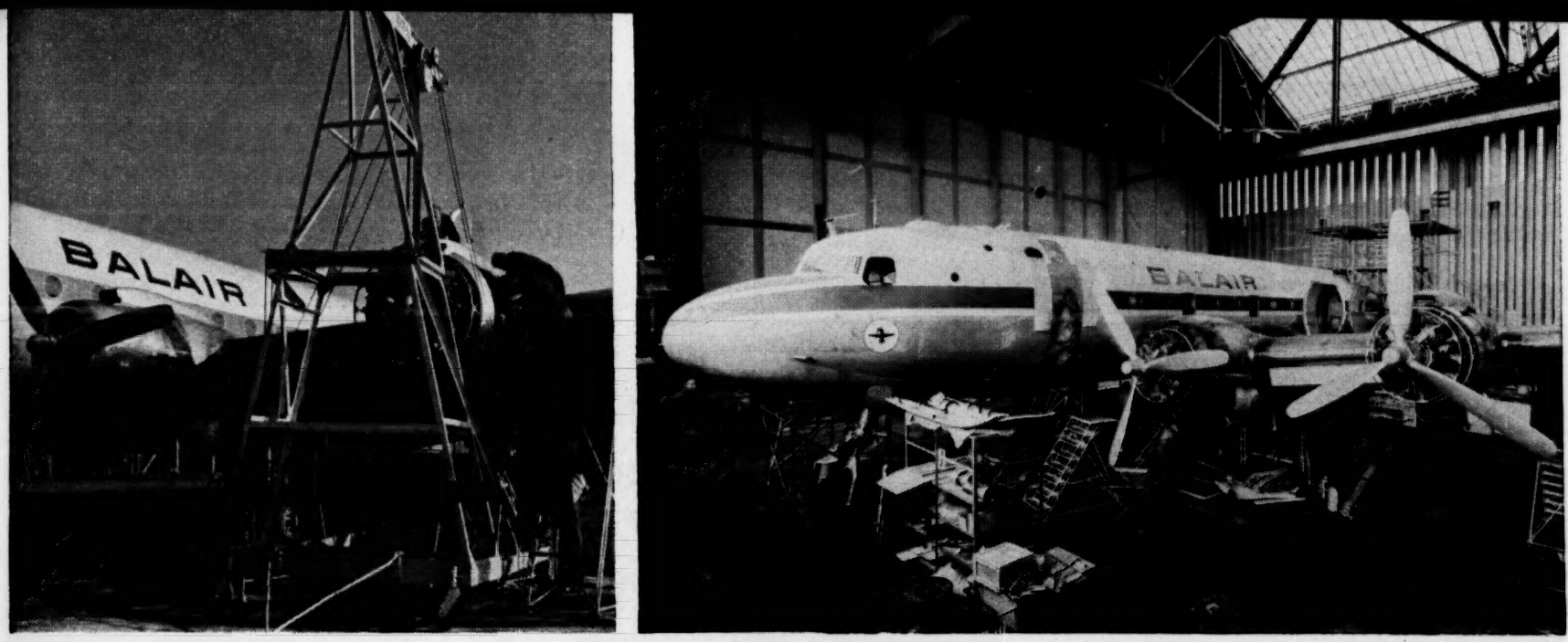
Capability has many faces at Boeing

THREE-ENGINE JET. Scale model of America's first short-range jetliner, the Boeing 727. Already, 117 Boeing 727s have been ordered by American, Eastern, Lufthansa and United airlines for delivery beginning late in 1963.

PLASMA PHYSICS. Boeing Scientific Research Laboratories scientist has verified experimentally, for the first time, a theory concerning ionized gas—important in future harnessing of thermonuclear power.

AUTOMATIC SKY FIGHTER. Supersonic Boeing Bomarc missile, now operational, is the United States Air Force's push-button defense weapon against airborne missiles and attacking bombers. New Bomarc "B" models have scored test intercepts up to 446 miles from base at altitudes of more than 100,000 feet.

BOEING



LOCAL MAINTENANCE and overhaul of Balair DC-4s up to 5,000 hr. is done locally. At left, DC-4 engine is changed after 1,500 flight hours. At right, DC-4 undergoes airframe check after 300 flight hours.

ticularly from England, visiting Switzerland and Swiss tourists, who favor summer vacations abroad. Most popular Swiss tourist centers are Greece, Spain and the Canary Islands, and Balair says it recently has a marked increase in demand during the winter for flights to Africa, Ceylon and the Far East.

In general, the all-in prices quoted by Balair for these long-distance round trips include the cost of a stay at a medium-class hotel as well as several excursions into the surrounding areas. For example, when Balair DC-6B round trips are introduced this winter, a 17-day vacation in Nairobi, East Africa, will cost $662 per person, a 21-day trip and stay in Ceylon can be had for $594 and a 31-day visit to Tokyo for $1,462.

100% Load Factor

"The advantage of our tourist charter business, which accounts for at least half of our total turnover throughout the year," explained Gersbach, "is that we can operate on the basis of a 100% load factor compared with the 60% maximum attained by any scheduled carrier. Reason for this is that most of our so-called 'chain flights' are organized by travel agents, who hire from us the whole aircraft, not just a certain number of seats. The prices we quote them, payable in advance, are normally calculated on a flight-hour basis and include all overheads and extras such as insurance, fuel, servicing and maintenance costs, crew out-of-pocket en route expenses and so on. By transferring the load factor risk like this to the hirer of the aircraft, a Balair charter flight tourist saves about 40% of the normal airline fare he must pay for the same trip."

From April to October, the peak summer travel months, Balair says it can count on an order for one of these chain flights every one-to-two weeks. Popular destinations during the last two full summer seasons were Athens, Barcelona, Malaga, Lisbon, London, Copenhagen, Marseilles, Rabat, Rimini, Teneriffe, Tunisia, but particularly Las Palmas. The charge for the round trip between Basle and Las Palmas, including a 14-day stay there, is $97 per person.

"But it is remarkable," Gersbach told AVIATION WEEK, "that the bulk of tourist air travel still seems to be confined to Europe and a variety of centers farther eastward. I have to visit scores of different places on business during the year and nearly everywhere I find the need for more travel offices and information on all aspects of tourist possibilities in the United States.

"Most Europeans still believe in the fallacy that the cost of a vacation spent in the United States is prohibitive. I know for a fact that U.S. prices compare favorably with those charged in some of the popular European resorts.

"Earlier this year, SAS Scandinavian Airlines System, among other airlines, made an effort to get IATA to approve all-year excursion fares to the U.S., or at least to extend the winter-month 17-day excursion fare rate to 23 days to make it worthwhile for Europeans to spend their vacation in the U.S. But that's only a drop in the ocean. It'll require a lot more than that to fill all the vacant seats now going begging on the transatlantic routes. Balair needs to increase its cross-Atlantic business, too, and we're prepared to contribute proportionately to the joint effort required to accelerate air traffic in that direction."

Standby Service

Balair is on call to handle surplus passenger and/or freight flights for a number of the major scheduled carriers, particularly Swissair, in addition to KLM Royal Dutch Airlines, Sabena Belgian World Airlines, SAS, Air France and El Al Israel Airlines.

During last summer's disturbances in the Congo, the company was required to transfer two Vikings, two DC-4s and a total of 50 technical, flying and administrative staff members to Leopoldville within 24 hr. after the first call was received. Under the command of ONUC (Organisation des Nations Unies au Congo), Balair aircraft carried food supplies from their Leopoldville base to the hunger-stricken population of the South Kasai area. Flying three to four missions daily, the four aircraft logged almost 2,500 flight hours in about 200 flights during the 5½ months of their share in the Congo airlift.

Balair's charter aircraft and flight personnel have to maintain the same standards of efficiency as those of any scheduled airline. Like the national carrier, Swissair, Balair's equipment and personnel are subject to the same Swiss Federal Air Office regulations and frequency of control.

Maintenance Procedure

The company's maintenance facilities are limited, which is why the manufacturer, Bristol Aircraft, Ltd., Bristol England, carries out maintenance and overhaul of the Bristol 634 Viking engines. The Pratt & Whitney R-2000 DC-4 powerplants are serviced and overhauled in Copenhagen by SAS, which did this work previously when the DC-4s were Swissair-owned. Both engine types are dismounted and replaced after a total of 1,500 flight hours.

With the purchase of its first two DC-4s from Swissair, Balair received a detailed DC-4 airframe and overhaul handbook, the recommendations of which are closely followed by Balair technicians. The system works like this:

In a series of six successive checks after every 300 flight hours, Balair mechanics, under the supervision of two technical Swissair specialists and a DC-4 instructor, control and service every part of the airframe. This work takes four days (600 man hours). Major overhaul cycle begins at 1,800 hr. and is completed after 5,000 hr. (6,000 man hours), but Swissair carries out the more extensive 5,000 and 10,00 hr. revisions and will continue to do so until Balair's own workshops are sufficiently equipped

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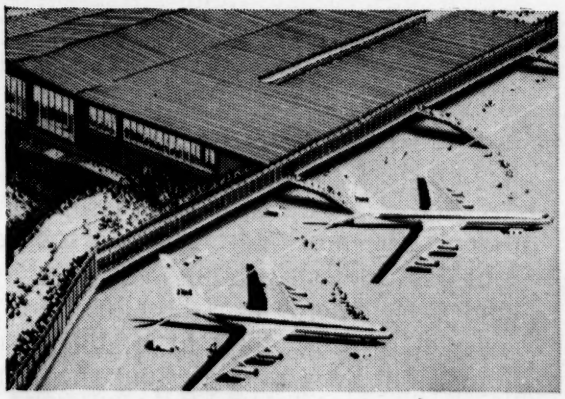
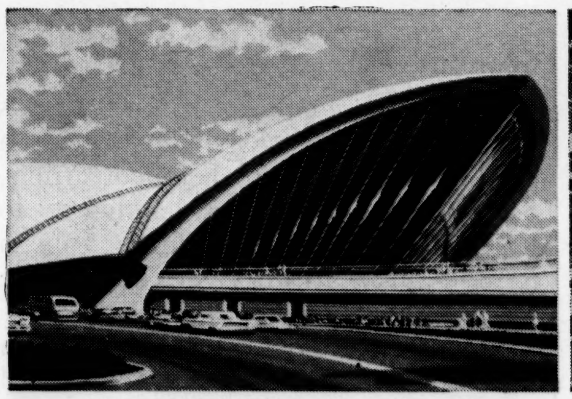


ROME—new TWA facilities serving Rome, opened this year in the new terminal at the Leonardo da Vinci Airport, Fiumicino.



NEW YORK—this TWA terminal soon to open at the International Airport reflects the jet age in soaring concrete.

CHICAGO—coming soon TWA's new, jet-age terminal with many new features of O'Hare International Airport.

to undertake the entire maintenance program locally.

Maintenance and overhaul of the two smaller, less complicated Vikings is handled by Balair technicians at Basle airport. For example, by the time the Viking airframes undergo their fourth check after 1,380 flight hours, a minimum of 780 different items have been serviced and checked off the control list. Twelve technicians are required to carry out this job, which keeps the aircraft grounded for four weeks. A Federal Air Office specialist spends an average of two full days a week in Balair's workshops to ensure that the aircraft conforms with official airworthiness standards before it re-enters service.

The company's flight personnel must submit to periodic examinations, generally following the lines of those in force by scheduled airlines, to ensure that they are familiar with the various navigational and landing aid procedures at the other airports visited. Following the obligatory medical examinations, Balair's captains and copilots pass an efficiency test twice yearly.

Test program of the captain of a four-engined aircraft includes:

- **Takeoff with one engine cut out** so that the aircraft has to be flown on instruments as soon as it is airborne.
- **Three-engine ILS** (instrument landing system) takeoff.
- **ILS takeoff and direct landing** on two engines with which the test is completed.

Balair's pilot school and training section supplies the specialists qualified to carry out these examinations which are frequently monitored by a representative from the Federal Air Office.

Both Balair's flight personnel and technical staff are required to take special training courses. These involve six weeks theoretical and practical training for flight personnel, four weeks technical training for engineers and mechanics, whenever any aircraft is purchased with which they have had no previous experience.

A number of Balair pilots have qualified and served several years with Swissair prior to joining Balair. Four of them have logged a total of about 12,000 flight hr. Flight engineers and navigators presently serving on Balair's DC-4s also are former Swissair personnel who were transferred to the charter company with the purchase of the aircraft.

General aviation interest following World War II had increased sufficiently to provide the basis for Balair's reestablishment on a limited scale in 1948. However, it again had to overcome a series of tribulations during the first few years until it finally gained Basle government approval and financial support for the formation in January, 1953, of the Balair A.G. shareholding company.

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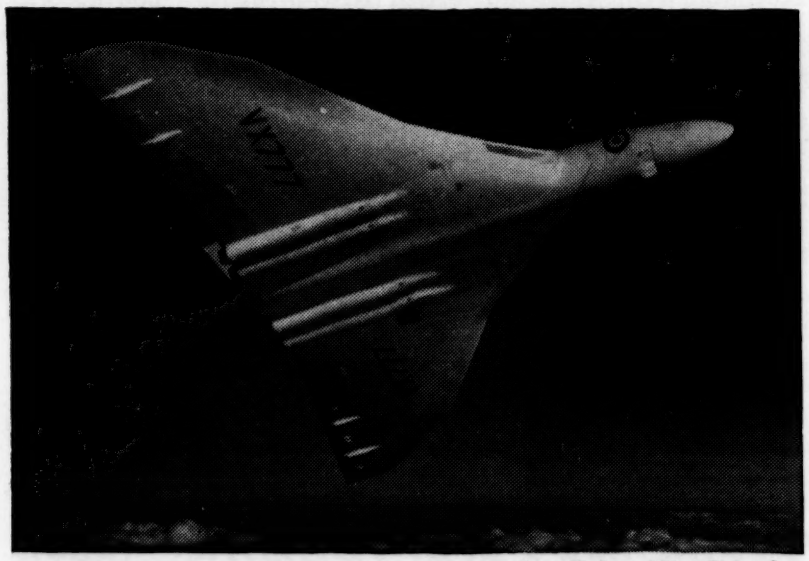

Avro Vulcan Mk 2 V-bomber

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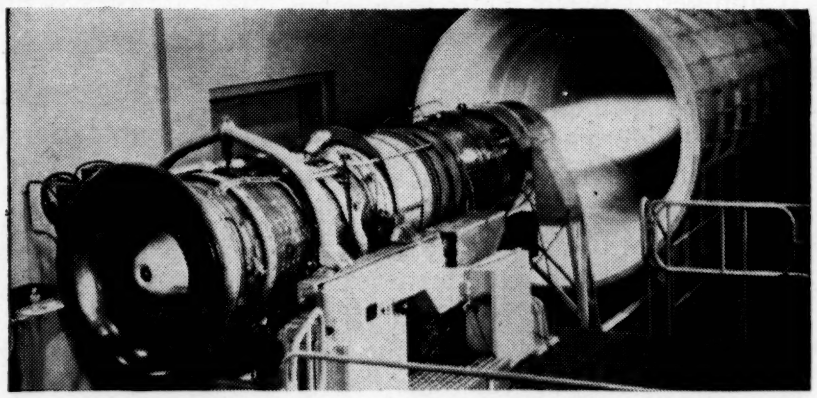
The Olympus has proved itself in several years' service, as the powerplant of the Avro Vulcan V-bomber, to be one of the most successful turbojets ever built. Maintenance is exceptionally low—last year, for example, on a 26,000-mile, round-the-world tour, the maintenance required was negligible.

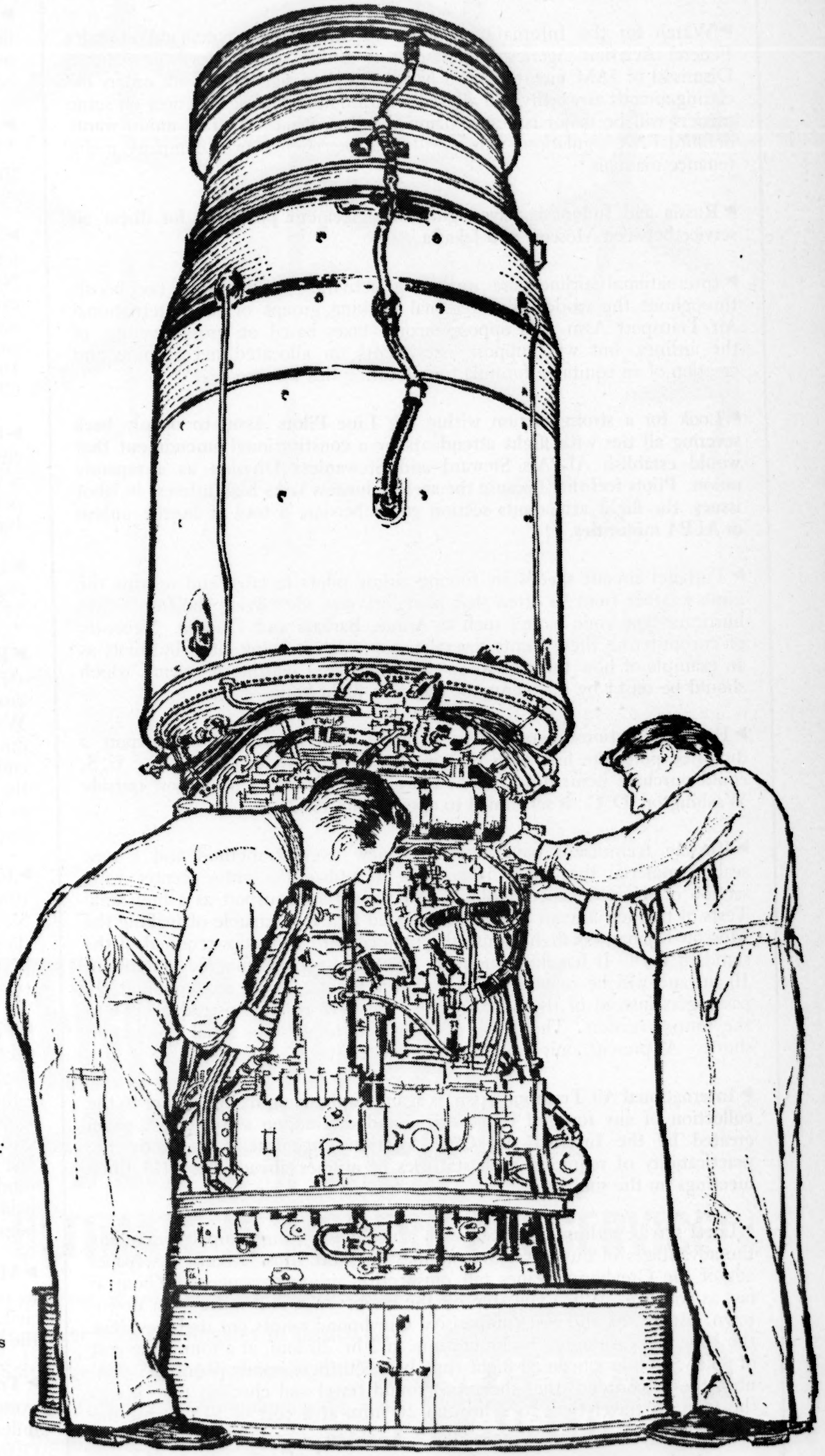
The truly astonishing built-in potential of the Olympus has been confirmed by the threefold increase in power from the 11,000-lb thrust dry of the original production engine, to the 33,000-lb thrust with reheat of the latest version.



Olympus under test with reheat in operation

SUITABILITY FOR SUPERSONIC AIRLINERS

Already selected for the RAF's most up-to-date supersonic aircraft, the Olympus will clearly require relatively minor changes to adapt it to the requirements of a supersonic airliner in the same speed category.



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AIRLINE OBSERVER

► Watch for the International Assn. of Machinists to demand stronger Federal Aviation Agency supervision of airline maintenance procedures. Dismissal of IAM members who have refused to sign final work orders declaring aircraft airworthy and allegedly hazardous refueling practices on some carriers will be major issues in planned talks with FAA. The union wants definite FAA regulations which will take precedence over company maintenance manuals.

► **Russia and Indonesia have signed an agreement providing for direct air service between Moscow and Jakarta.**

► International airlines are increasing activities in opposing tax boosts throughout the world. Ten regional working groups of the International Air Transport Assn. will oppose income taxes based on gross revenues of the airlines, but will support assessments on allocated net income and creation of an equitable formula for allocating this income.

► **Look for a strong faction within Air Line Pilots Assn. to openly back severing all ties with flight attendants by a constitutional amendment that would establish ALPA's Steward and Stewardess Division as a separate union. Pilots feel that because the average hostess lacks high interest in labor issues, the flight attendants section could become a tool of hostile unions or ALPA minorities.**

► Turbojet aircraft speeds are forcing airline pilots to cross and re-cross the same weather front so often that pilots are now identifying the fronts with hurricane-type code names such as Annie, Barbara and Claudia. Necessity of encountering these fronts several times a day is being cited by pilots as an example of how turbojet speeds have increased piloting problems, which should be offset by a lowering of monthly flight time.

► **Federal Aviation Agency plans to make Dulles International Airport a duty-free port, the first such port in the U. S. Travelers leaving the U. S. could purchase items duty free at the airport. Dulles, a jet airport outside Washington, D. C., is scheduled to open in late 1962.**

► Russian technicians have adopted a new riveting method and a new sealing material that make it possible to utilize the entire center wing section of the new experimental Il-18-1 turboprop transport as a fuel tank. Tests of the new aircraft have demonstrated that it is capable of making the Moscow-Khabarovsk flight nonstop compared with two stops required of the standard Il-18. It has flown nonstop Irkutsk-Moscow-Leningrad-Moscow in 10 hr. and will be capable of transatlantic flight. It will accommodate 92 passengers instead of the 84 carried by the Il-18 or 125 instead of 111 in the tourist version. The Il-18-1 is expected to go into serial production shortly. At present, only a single test model exists.

► **International Air Transport Assn. is again emphasizing its opposition to the collection of any form of traffic origin and destination statistics. A panel created by the International Civil Aviation Organization to study the practicability of requiring such statistics of airlines already has held three meetings on the subject.**

► Local service airlines are faced with a new advertising campaign extolling the advantages of bus travel over airlines on short trips. Recent newspaper ads of the Greyhound Lines tell prospective airline passengers: "Zoom as fast as you like. When you step off the ramp you're still miles from downtown." In a time and cost comparison, Greyhound points out its buses drive the 100-mi. Washington-Richmond run in 2 hr. 20 min. at a round-trip cost of $5.95. While scheduled flight time between these points is only 35 minutes, the ad contends that the extra ground travel and check-in time brings the total air travel time to 2 hr. and 20 min. at a cost of $18.80 for the round trip.

SHORTLINES

► **Air freight** carried by American Airlines totaled 13.2 million ton miles during October—an 18% gain over October, 1960.

► **Allegheny Airlines** reports it flew 77,118 passengers over 15 million mi. during October—a 14% gain over the same month last year.

► **American Airlines** will add an 11 a. m. jet flight daily between Chicago and New York. With the new flight, American now provides every-hour-on-the-hour service from Chicago to New York between 8 a. m. and 7 p. m.—except for 10 a. m.—and from New York to Chicago from 8 a. m. to 7 p. m.

► **British European Airways'** first Armstrong-Whitworth Argosy air freighter is scheduled to begin service eight times per week between London and Milan, Italy, on Nov. 26.

► **Central Airlines** reports 25,399 passengers boarded during October—a 75.8% increase over October, 1960.

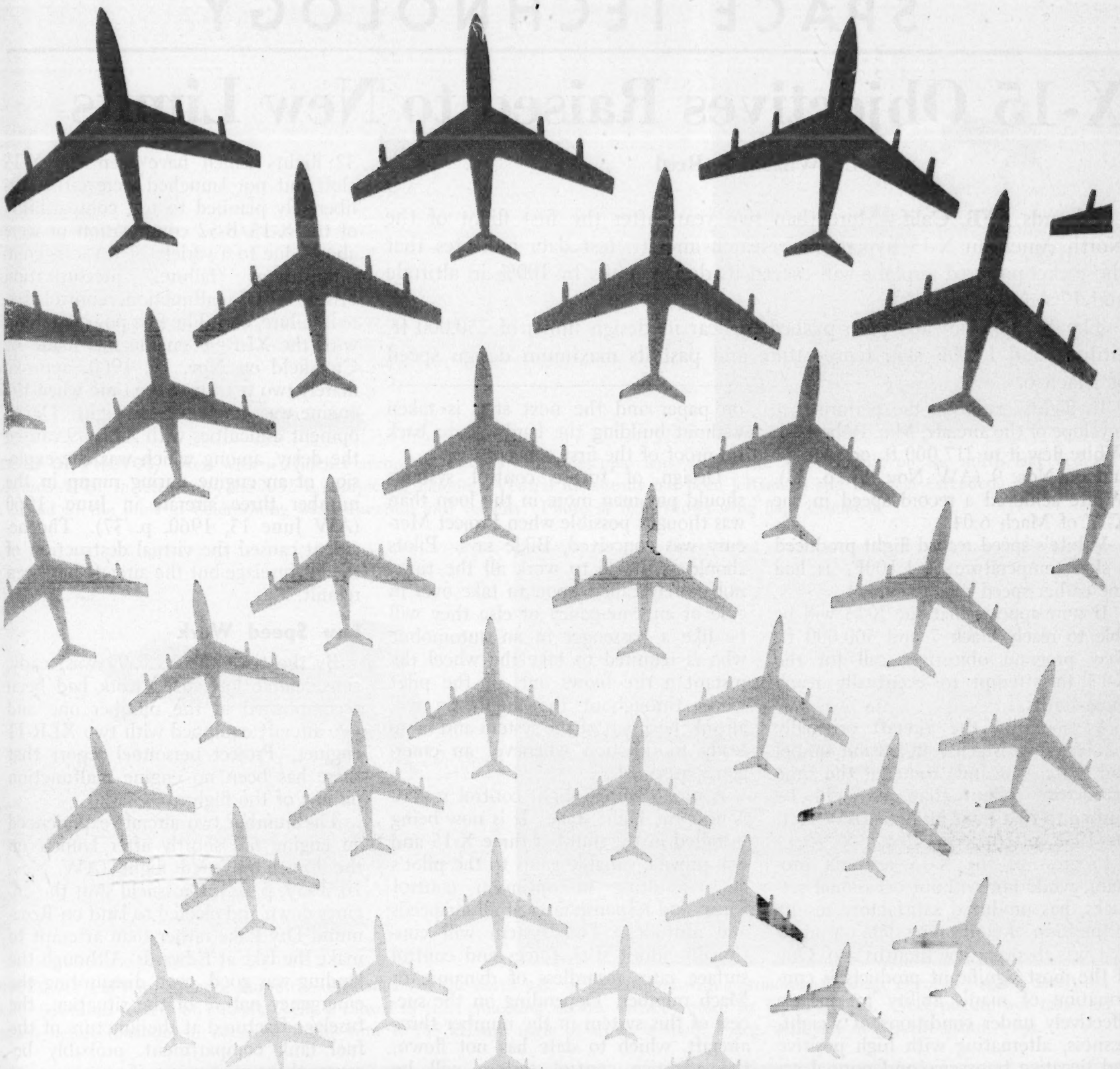
► **Eastern Air Lines** reports it will operate its air shuttle services on a "continuous" basis between New York and Washington and New York and Boston during the Thanksgiving holiday weekend. Eastern says its Constellations on the air shuttle routes will depart as fast as they can be loaded, unloaded, serviced and dispatched.

► **Federal Aviation Agency** has signed a 10-year agreement with the American News Company of New York for installation and operation of food and beverage facilities at Dulles International Airport.

► **Flying Tiger Line** reports it has flown over 4.2 million ton miles of freight during the first three weeks after Oct. 16—the date the airline began its new rate structure (AW Oct. 2, p. 45)—an increase of 13% over the same period last year and 23% over the preceding month. Flying Tiger reports its over-all load factor has increased 15% since it began the new rates.

► **Military Air Transport Service** has awarded $11 million in contracts to 15 civilian airlines for transportation during the last quarter of 1961.

► **Trans World Airlines** reports it flew over 103 million revenue passenger miles on its international routes during October—an 8% increase over October, 1960.



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WESTERN AIRLINES

X-15 Objectives Raised to New Limits

By William S. Reed

Edwards AFB, Calif.—More than two years after the first flight of the North American X-15 hypersonic research aircraft, test data indicates that the rocket-powered airplane will exceed its design limits by 100% in altitude and 17% in speed.

The X-15 already has been pushed to near its design limits of 250,000 ft. altitude and 1,200F skin temperature and past its maximum design speed of Mach 6.

In flights exploring the performance envelope of the aircraft, Maj. Robert M. White flew it to 217,000 ft. on Oct. 11 and on Nov. 9 (AW Nov. 13, p. 33), White achieved a record speed in the X-15 of Mach 6.04.

White's speed record flight produced a skin temperature of 1,100F, as had one earlier speed run.

It now appears that the X-15 will be able to reach Mach 7 and 500,000 ft. New program objectives call for the X-15 to attempt to eventually reach these limits.

A model of the aircraft originally was tested to Mach 7 in a wind tunnel and there were indications at the time of factory rollout that it might be pushed to that limit in flight (AW Oct. 20, 1958, p. 26).

Progress of the X-15 research program, while not without occasional setbacks, has produced satisfactory results in the form of confirming data on much that was theory a few months ago. One of the most significant products is confirmation of man's ability to operate effectively under conditions of weightlessness, alternating with high positive and negative transverse and normal accelerations. Of no less significance is data on aerodynamic heating, high temperature structures, throttleable rocket engine performance, bioastronautic data and upper atmospheric research on cosmic radiation.

Flight Data Gap

Paul F. Bikle, director of the NASA Flight Research Center, warns that there will be a gap in flight research data resulting from the lack of a suitable test vehicle to follow the X-15 within a reasonable time.

Early 1963 should see the end of the X-15 program as it was first laid down and this will be the start of a flight data famine that will continue until the Dyna-Soar vehicle reaches flight stage, probably a year and a half later, Bikle said. Dyna-Soar, he says, should have been started into the construction phase as soon as it was proved feasible on paper. Too often, concepts are proven on paper and the next step is taken without building the hardware to back up proof of the first concept.

Design of future control systems should put man more in the loop than was thought possible when Project Mercury was conceived, Bikle says. Pilots should be made to work all the time, not merely called upon to take over in case of an emergency or else they will be like a passenger in an automobile who is required to take the wheel the instant a tire blows out. If the pilot works throughout the flight, he will already be a part of the system and more ready to function whenever an emergency arises.

A new adaptive flight control system is near the flight stage. It is now being installed in the number three X-15 and will provide variable gains to the pilot's stick resulting in optimum control forces and response rates at all airspeeds and altitudes. This system will continually adjust stick forces and control surface rates regardless of dynamic or Mach number. Depending on the success of this system in the number three aircraft, which to date has not flown, the adaptive control system will be retrofitted to the other two aircraft.

Another control system modification soon to be flown will be the incorporation of stability augmentation into the reaction control system. The reaction augmentation system will damp out some of the unstable oscillations which occur at extreme altitude when reaction control is used. Lacking any damping action at low dynamic pressure, the X-15 is unstable with the present system. Reaction augmentation will make control during the ballistic portion of flight easier and more precise.

The two active X-15s in the program, Nos. 66670 and 66671, had been aloft a total of 77 times by the middle of November. Powered flights were made 29 times with the XLR-11 engines and 15 times with the XLR-99 RM-1 57,000-lb. thrust engine. One unpowered free flight, the first, on June 8, 1959, was made by North American Aviation Test Pilot Scott Crossfield. The remaining 32 flights which have seen the X-15 aloft but not launched were either deliberately planned to test compatibility of the X-15/B-52 combination or were aborts due to a variety of reasons—communications failure, pressurization losses, APU malfunction, control system failure, etc. The first powered flight with the XLR-99 engine was made by Crossfield on Nov. 15, 1960, approximately two years past the time when the engine was scheduled for flight. Development difficulties with XLR-99 caused the delay, among which was the explosion of an engine during runup in the number three aircraft in June, 1960 (AW June 13, 1960, p. 37). The accident caused the virtual destruction of the aft fuselage but the aircraft has been rebuilt.

Low Speed Work

By the time the XLR-99 was ready, considerable low speed work had been accomplished in the number one and two aircraft equipped with two XLR-11 engines. Project personnel report that there has been no engine malfunction on any of the flights.

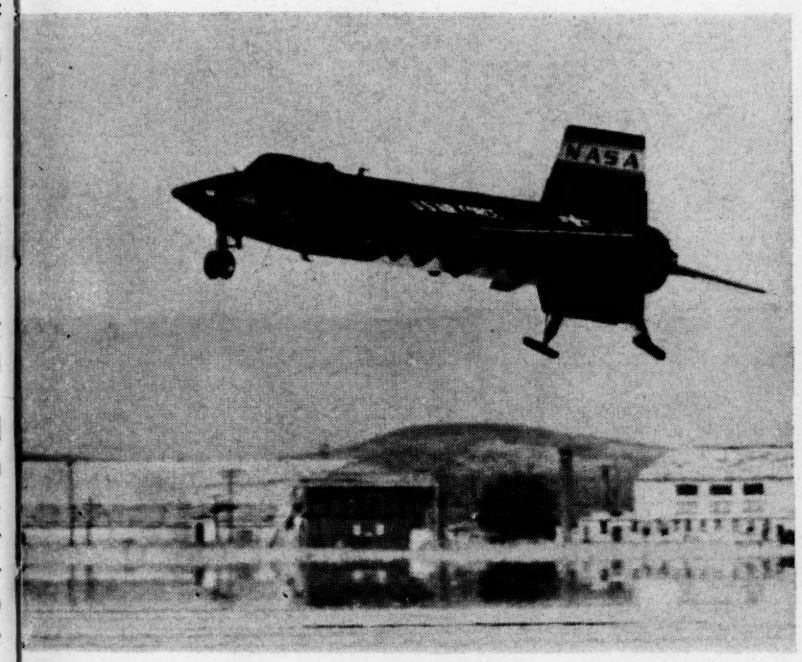
The number two aircraft experienced an engine fire shortly after launch on the fourth powered flight (AW Nov. 16, 1959, p. 32). Crossfield shut the engines down and elected to land on Rosamund Dry Lake rather than attempt to make the lake at Edwards. Although the landing was good, even discounting the emergency nature of the situation, the fuselage fractured at the juncture of the fuel tank compartment, probably because there was a significant amount of unjettisoned propellant aboard. Complete fuel jettisoning did not occur because of the nose down attitude of the aircraft, resulting in a higher than design weight at landing.

With the characteristic rapid fall-through of the nose, the structure yielded and the aircraft broke its back. Repair was rapid, however, and the aircraft flew again on Feb. 11, 1960, three months after the accident.

Management of the $225-million research program is under the direction of the National Aeronautics and Space Administration. Actual direction of the program emanates from the NASA Flight Research Center at Edwards AFB including flight test planning and data reduction. Maintenance of the three X-15s is performed by NASA—the Air Force maintains the two B-52 carrier aircraft.

Modifications for depot-type maintenance on any of the five aircraft or re-

SERIES OF PHOTOS, taken with a Hulcher automatic camera with telescopic lens, shows the X-15 landing on the north lake bed at Edwards AFB. In left photo, the X-15 is completing flareout. Ventral fin already has been jettisoned and the gear extended. Smoke flare is an aid to the pilot in determining wind direction and velocity. Photo at right shows wing flaps extended.



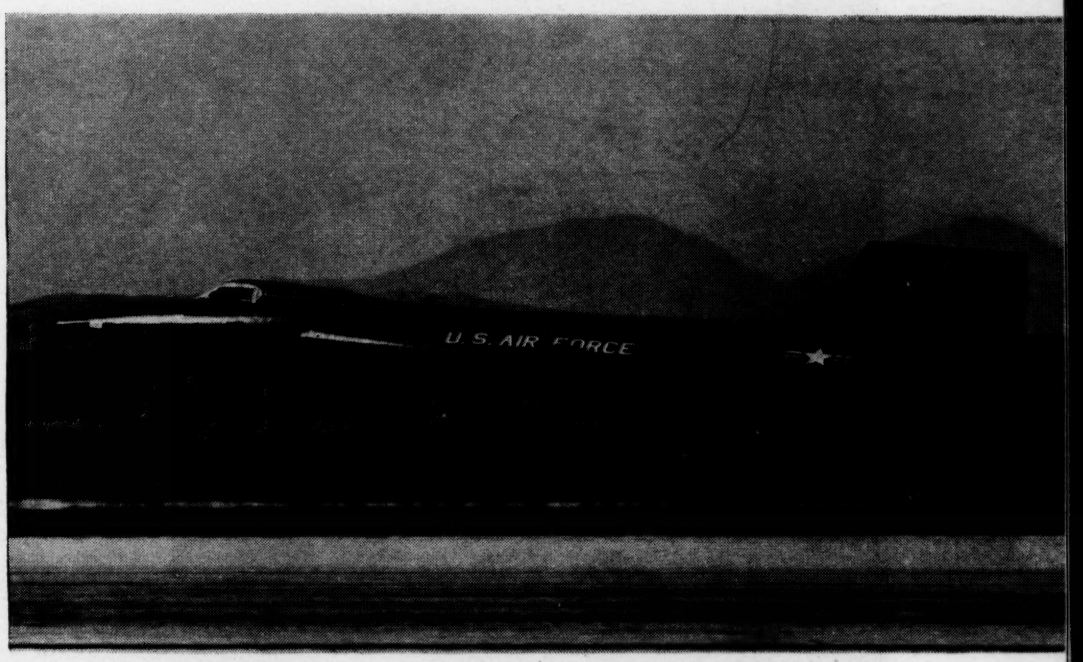
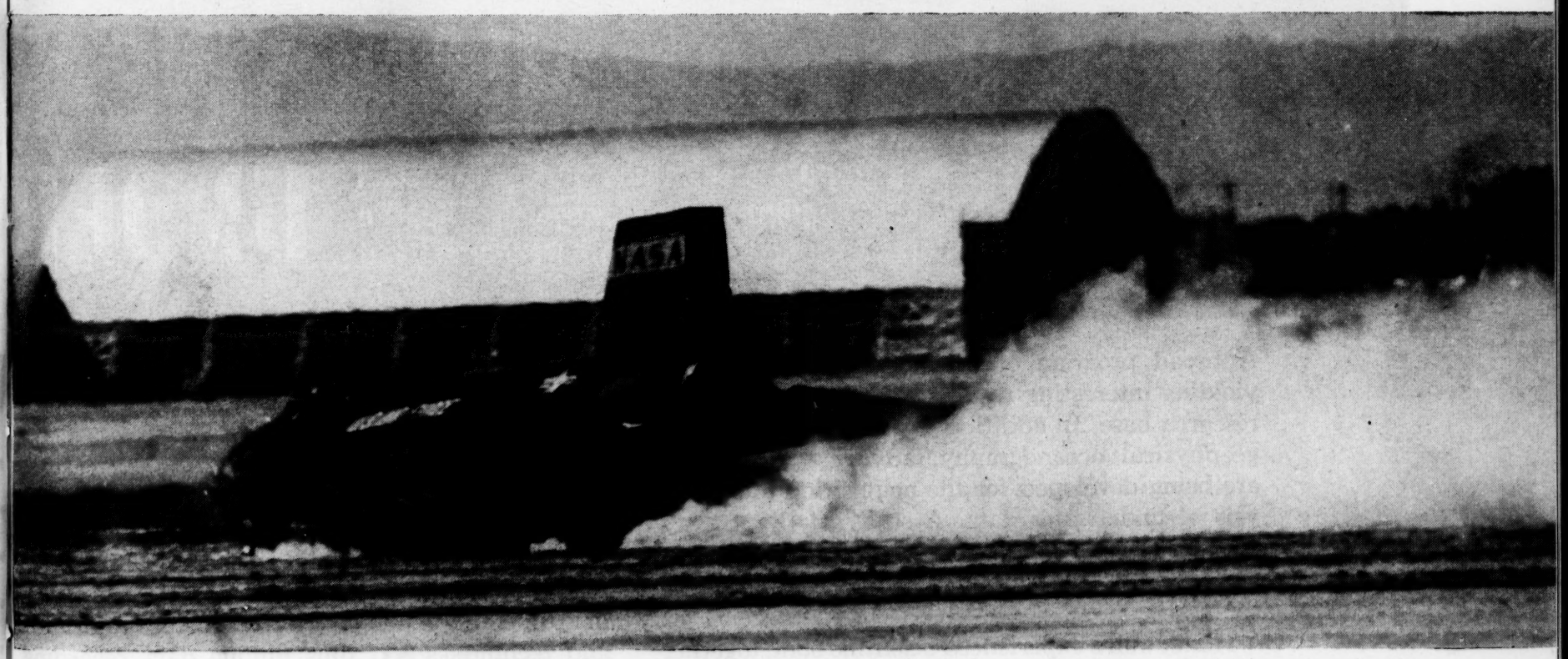
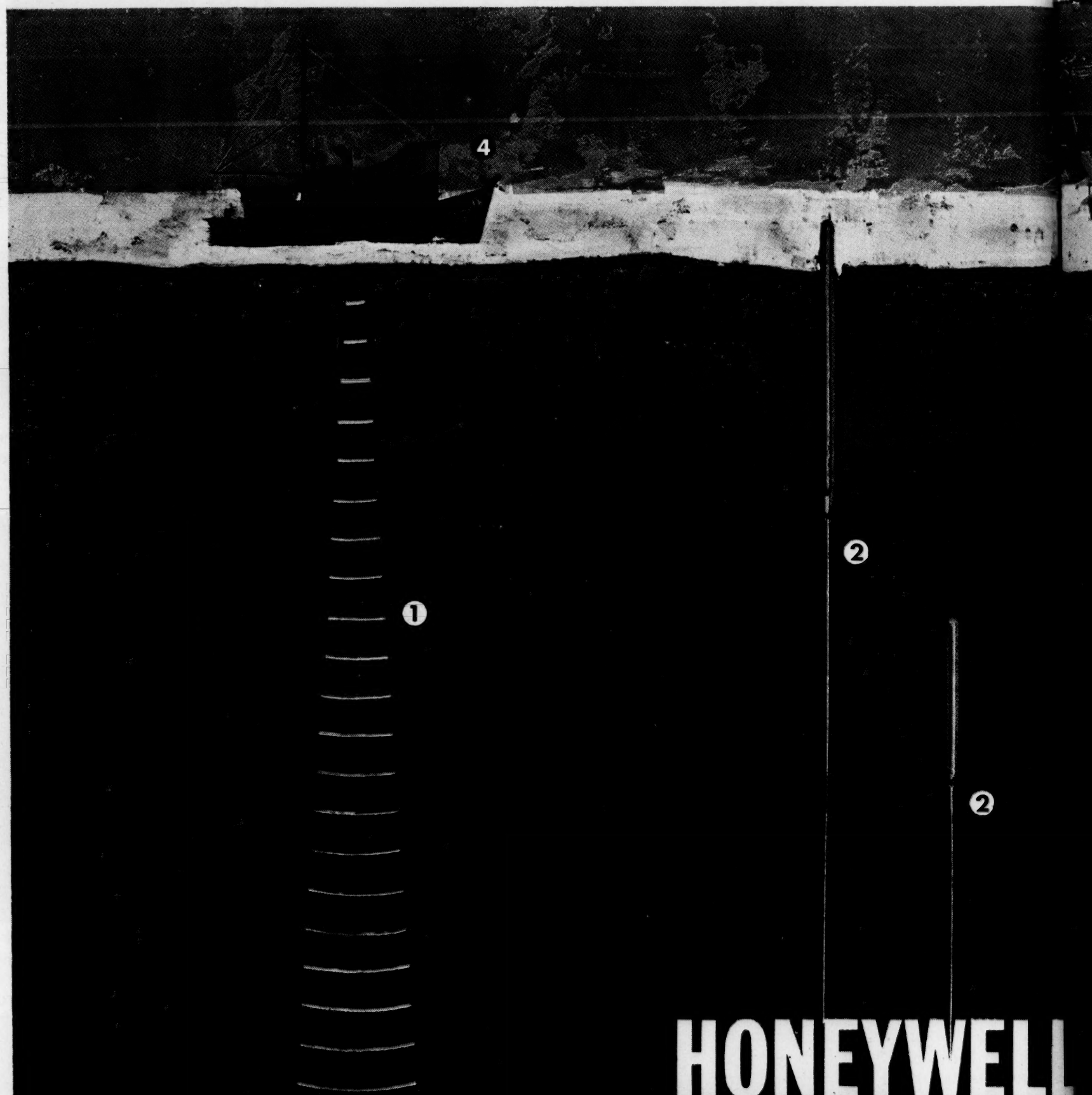


PHOTO AT LEFT in sequence shows the old hangars of the north base in background with a pronounced mirage effect of the hot desert evident. Sawtooth pattern on aircraft's belly is caused by frost collecting on the surface cooled by liquid oxygen. Next picture was taken an instant before touchdown. Airspeed at this time is 185 kt. and angle of attack is about 7 deg. with rate of descent about 4 fps.



X-15 is shown rolling out after touchdown. Lake bed appears rougher than it actually is due to foreshortening of the surface by the camera's telescopic lens. Directional control is maintained by aileron deflection which places more or less weight on the appropriate skid.



HONEYWELL UNDER

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A broad program of oceanographic research is yielding interesting results at Honeywell's ocean-research base. In addition to studies and R&D in geophysical oceanography, advanced techniques are being developed for the acquisition and analysis of underwater data. A study of the ocean's variables and development of underwater instrumentation are also proceeding under contract to the U. S. Navy.

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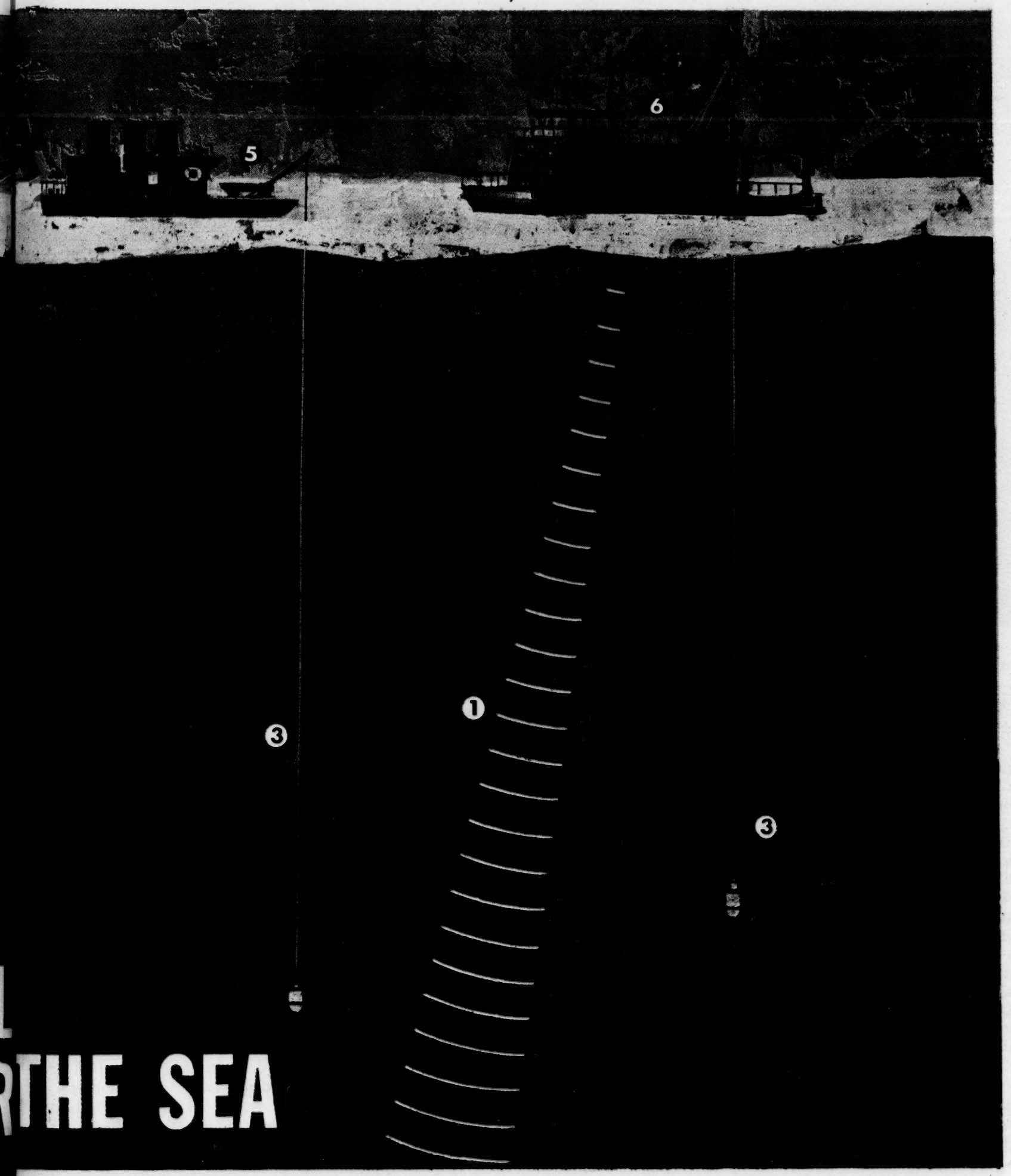
Principal areas of Honeywell activity include: **OCEANOGRAPHIC INSTRUMENTATION** — Research and development of high-output, low-frequency research sound sources ❶, surface and subsurface instrumentation buoys ❷, telemetry equipment and techniques ❸, plus unique data recording,



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torage and display techniques and equipment.
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FULL DETAILS *on request. Address: Dr. T. F. Hueter, Honeywell Seattle Development Laboratory, Seattle 3, Washington.*

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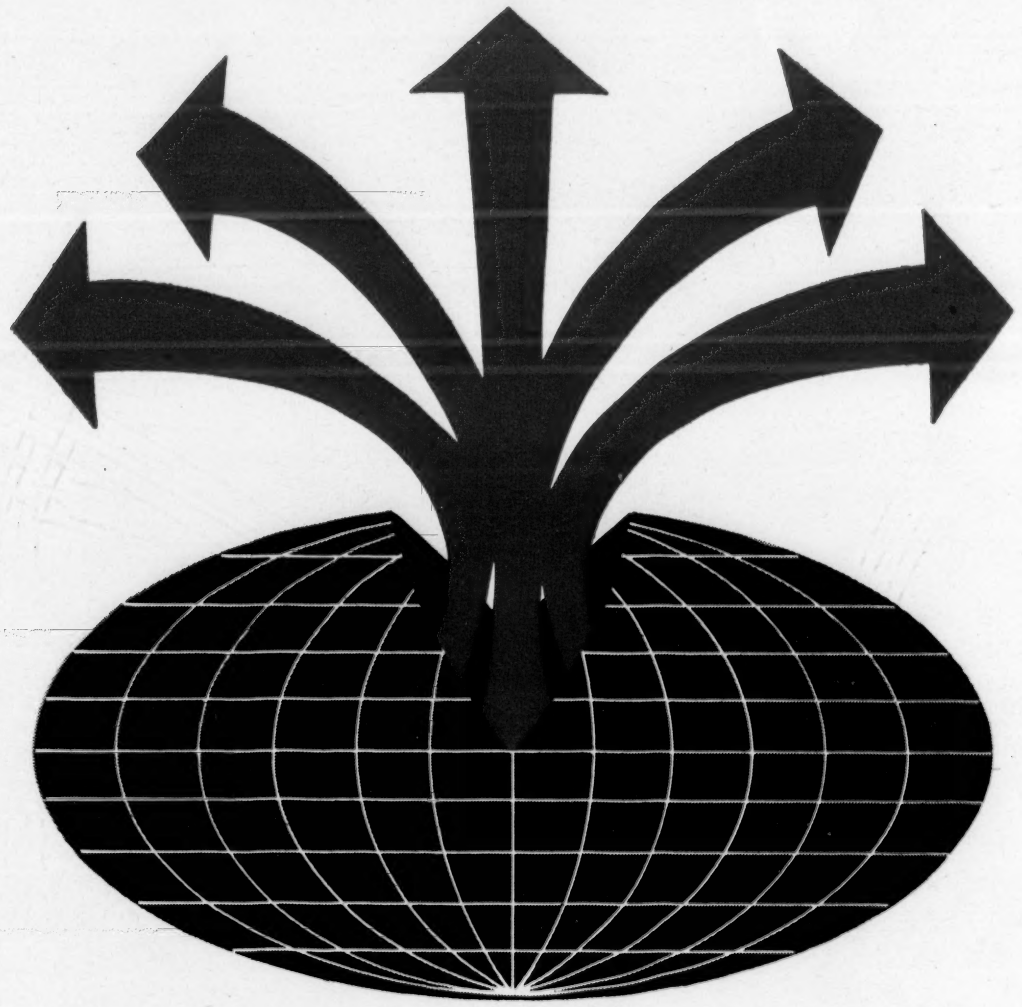

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SIX PILOTS CURRENTLY INVOLVED in the X-15 flight research program are shown beside their vehicle. The pilots and the number of powered flights they had made as of Oct. 25, 1961 are, left to right, John B. McKay, NASA, (2); Joseph A. Walker, NASA (9); Cdr. Forrest S. Petersen, USN (4); Maj. Robert A. Rushworth, USAF (3); Neil A. Armstrong, NASA (2); and Maj. Robert M. White, USAF (10). Scott Crossfield, North American Aviation, completed the contractor portion of the program with his 13th powered flight on Dec. 6, 1960.

ated components usually are handled by the manufacturer under terms of open contracts let by the Air Force. Actually, careful delineation of which group—Air Force or NASA—handles what in the program is difficult to determine since in the whole effort teams from both sides work in parallel and it is difficult to distinguish where one leaves off and the other begins.

Considerable instrumentation has been installed by NASA at the Edwards station and in the High Range stations (AW Feb. 23, 1959, p. 28) for data gathering, but the High Range extending from Edwards to near Wendover, Utah, was contracted for by the Air Force. It is maintained under NASA contract by the Bendix Corp.

Funding provided by the U.S. Navy is relatively small, amounting to $7.4 million, or about 3% of the total. NASA has spent about $45 million and the remaining $172 plus million is Air Force funded.

X-15 has handling characteristics similar to Century Series fighter aircraft including high sink rate, trim change in the transonic region, and slight undamped stability variations without stability augmentation. Maj. Robert M. White describes the X-15 as typical of high lift/drag aircraft and without serious fault as to stability and control parameters for a pilot versed in the foibles of present day high speed fighters.

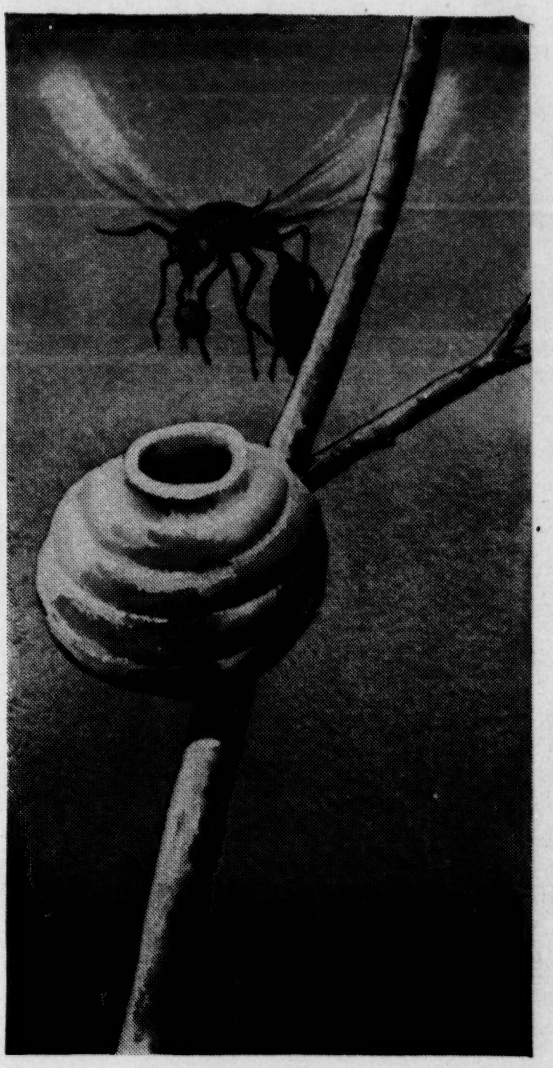
White told AVIATION WEEK that the X-15 is "rock solid" throughout all speeds with the stability augmentation system on, and flyable with the system off although somewhat less manageable, as are most supersonic aircraft without stability systems.

White's flight to 217,000 ft. recently was controlled entirely with the side stick, a controversial feature which almost caused the loss of the number one X-15 on its first glide flight. North American Aviation Pilot Scott Crossfield declared before the flight that he would use the side stick for the entire flight and got into serious trouble when he began the landing flareout because the response rate of the stabilator, (or one-piece stabilizer-elevator) was too slow. Data from that flight shows that the side stick controller was pushed to both its forward and rearward stops while the pilot tried to flare the aircraft with a stabilator response rate of 15 deg./sec. Later, the gain was changed to provide 25 deg./sec. rate and with this more realistic response, the side stick became usable.

Use of the side stick minimizes transient control inputs which can be appreciated by anyone who has undergone significant amounts of transverse g. Under power, the X-15 will accelerate along its longitudinal axis to more than 3.5g at engine burnout. This occurs while climbing at an angle of 32 deg. on altitude flights which probably will approach 60 deg. when a full-throttle maximum altitude attempt is made.

Of still greater concern from the control standpoint is negative transverse g in combination with positive normal g experienced on re-entry. Transverse g is measured parallel to the X-15 thrust axis. A negative transverse g acts to move the pilot forward in his seat, positive transverse g tends to force him back in his seat. White's descent from 217,000 ft. forced upon the X-15 a maximum normal acceleration of 4.5g and a transverse acceleration of −2.8g. Use of a center-mounted control stick probably would have forced the input of unwanted fore and aft control movements while the pilot was executing the task of maintaining a proper re-entry attitude.

Negative transverse acceleration requires more in the way of physical restraint for the pilot's body than any other maneuver. Of particular concern



Engineered Environment

The thimble-sized nest of the potter wasp is a feat of engineered environment as well as artistry. The mother wasp carefully gathers hundreds of particles of wet clay and positions them inside the nest so that air can circulate around them. This maintains proper humidity for larvae during the hot, dry months.

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THE Bendix CORPORATION

is the need to restrain the pilot's head to prevent the head and the protective helmet from being forced forward and down by virtue of its own weight. Securing the helmet to the headrest by a cable or some other means was ruled out because of possible complications of escape procedures.

Support for the head during negative transverse g is provided by building a helmet rest into the top of the cockpit canopy. The forehead is rested against a support and the head prevented from slumping forward during longitudinal deceleration.

Restraints also are applied to the rest of the body to keep the pilot well positioned during all phases of flight. Of particular concern is the need for support for the pilot's arms in a manner that will reduce as much as possible unwanted movements which may be introduced into the control system.

Planned Profile

Each of the X-15 pilots tries to fly every prescribed mission as nearly as possible to the planned profile—not from the standpoint of exceeding the limits of safety but from the standpoint of professional pride. White's altitude flight was profiled for a maximum altitude of 200,000 ft. and he was not pleased with having overshot the mark by 17,000 ft. He would rather have had it come out exactly on the planned altitude if only to prove that he could hold the exact pitching moment flight path as planned.

As it was, slightly more nose up pitching moment than he would have desired was introduced into the aircraft by the reaction control system as he was endeavoring to hold a 32-deg. attitude on the way up. The higher angle acquired after engine burnout about 130,000 ft. caused the extra altitude to be gained.

A new feature in the X-15 is a control system, soon to be tested, which will integrate the reaction control system into the same control stick with the aerodynamic system. Phase-in from one system to the other will be automatic and smooth as necessity dictates. In other words, if the aircraft has passed far enough out of the atmosphere so that the aerodynamic control system begins to lose effectiveness and the pilot commands a 150 deg./sec. roll rate but the aerodynamic controls will provide only 120 deg./sec. the reaction system will add the additional 30 deg./sec. necessary. More and more percentage of the control will be taken over by the reaction system as dynamic pressure becomes less and vice versa. Obviously, with all the parameters that must be sensed for smooth functioning of such a system, considerable testing will be necessary before the system becomes useful. Until then, reaction control still

How OGO keeps its eye on the ball

When OGO* goes into space carrying as many as 50 scientific experiments for NASA it must maintain proper orientation up to a year in orbits varying from near-earth to cislunar. A new horizon scanner system, an outgrowth of the highly successful scanner used in all Discoverer satellites, is being developed by Advanced Technology Laboratories to provide OGO with vertical reference data. This advanced scanner system continuously monitors the earth's infrared horizon and initiates corrective action as attitude changes are detected.

ATL's system was selected by Space Technology Laboratories, Inc. because of its unique ability to meet the requirements of high reliability and accuracy, long life, orbital flexibility and minimum size, weight and power.

ATL is also actively engaged in the development and manufacture of other satellite stabilization components and systems, including optical rate/yaw Sensors and micro-thrust reaction control systems. Individuals interested in challenging career opportunities at this "Equal Opportunity Employer" on the San Francisco Peninsula should direct resumes and inquiries to the Personnel Department.

*Orbiting Geophysical Observatory—the free World's first standardized scientific satellite is being developed and constructed by Space Technology Laboratories, Inc. for the National Aeronautics and Space Administration.

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Strong steel skin for the Skybolt

An Air Force B-52 bomber will be able to hide in the sky and launch four Douglas Skybolt nuclear missiles at targets 1,000 miles away when this air-launched ballistic missile becomes operational! The Skybolt, presently under development, will give us another strong deterrent against enemy attack.

To obtain this long range, Douglas designers had to trim every ounce of dead weight from the Skybolt without sacrificing strength or performance. They used an ultra-high-strength steel sandwich-rolled between two other steel plates to obtain highly uniform gage and extremely smooth surface. The result—a steel motor case of great reliability. Sandwich-rolled sheets are also commercially available for other industrial applications.

The search for stronger, lighter-weight components has led to general use of ultra-high-strength alloy steels for vital parts of rockets, missiles and aircraft. United States Steel has been a pioneer in their development. All USS Aircraft Quality Steels are accurately controlled during production to meet military specifications, and to assure uniform cleanliness and maximum responsiveness to heat treatment. Our metallurgists are ready at all times to help you make the best selections. For more information, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa. USS is a registered trademark.

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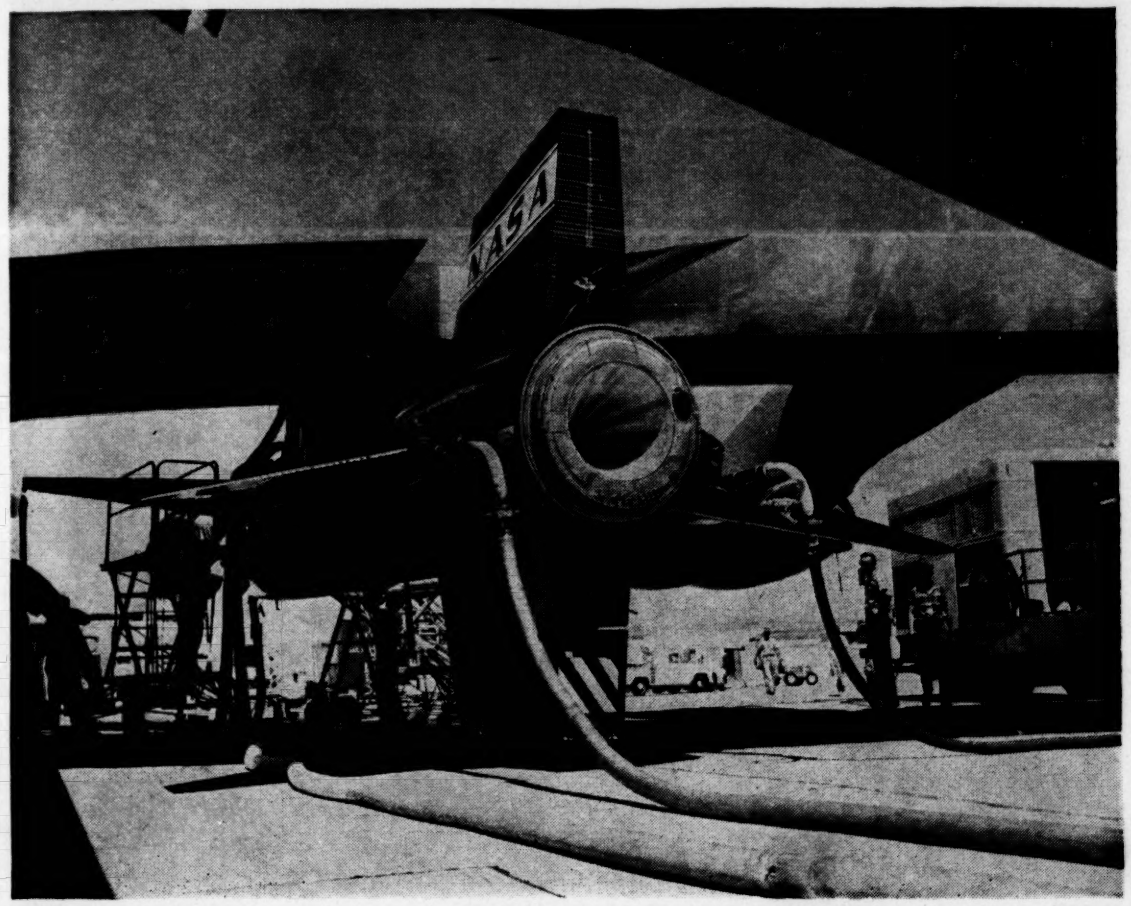

BELLY OF THE X-15 is covered with frost as fueling is conducted just prior to takeoff. Burning time of the Thiokol XLR-99RM-1 engine is averaging about 80 sec. per flight. The engine produces 57,000 lb. of thrust. Speed brakes are just above and below the rocket engine exhaust nozzle.

will be handled with the left side stick as it now is.

Recovery from extreme altitude, such as the flight in which White reached 217,000 ft. and the aircraft's velocity afforded only 3 psf. dynamic pressure, is not like recovering from a stall as might be expected. A combination of gradual g buildups from zero to 4.5 eliminates any aerodynamic buffeting.

White says he had the impression before his first re-entry that there might be some buffeting as the aircraft began to fly again after merely falling but sufficient indicated airspeed is attained before 1g is reached so that the X-15 is not flying in a stalled condition. Transition from a minimum of 3 psf. over the top to the point where sufficient dynamic pressure of about 260 psf. is reached is smooth and entirely without the suspected stall buffet, White says.

Stabilator Trimmed

During the ballistic portion of flight when dynamic pressure is too low for the aerodynamic controls to function, the stabilator is trimmed to a precalculated angle which will give it the required bite when sufficient dynamic pressure is attained. Until that time, attitude is maintained by the use of the reaction control system. Less and less reaction control action is needed as airspeed gradually builds up to the point where the aerodynamic system takes over. The preset angle allows for the aircraft to be in reasonable trim state when speed builds up to the point where flying starts again.

Knotty problems exist with respect to the ability of the X-15 to reach predetermined landing points during different portions of the flight. There are about two dozen lakes in the vicinity of the flight path on which successful landings can be made. However, there is a constantly changing cardioid-shaped (heart-shaped) pattern varying with changing airspeed and altitude which covers that portion of the ground which the aircraft can reach at any given time.

Turning Radius

How far the aircraft can glide is a function of the energy built up in the machine, both potential and kinetic. Under most conditions, the X-15 can glide for about 200 naut. mi. but the closest field it could successfully be maneuvered into is about 25 naut. mi. ahead of it. Therefore, the aircraft could be over Edwards at maximum speed or altitude and be unable to maneuver for a landing on the lake. There simply is no way for the energy in the machine to be judiciously expended in maneuvering or by absorbing it in aerodynamic drag. Turning radius at high speed or at high altitude is very great and if the pilot were to try to spiral down from a high altitude and high speed condition to a point directly beneath him he would fall about 25 mi. short of the intended landing.

This unusual feature has been drilled into all seven X-15 pilots and they are advised by controllers manning a plotting board in the NASA communication center what the state of the energy in the aircraft is. Additionally, rough

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X-15 RESTS ON EDWARDS LAKE BED after landing while the B-52 carrier aircraft flies by in a customary salute. Fire and rescue crews are on hand moments after the aircraft comes to a stop and immediately neutralize residual fuel which drains onto the ground. Note scorched NASA marking band on vertical tail. Heat-sensitive paint is used at times for special readings.

rules of thumb are calculated before each flight. For example, White calculated on his altitude flight that he could maneuver back into Mud Lake over which he was launched if the engine failed at any time before 33 sec. after ignition.

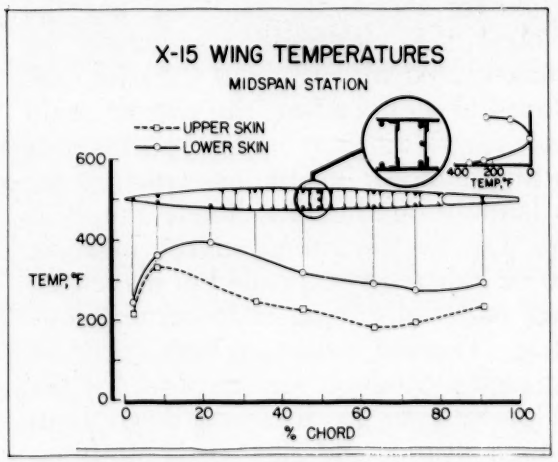
If failure occurred after that, he would try for one of the intermediate lakes or for Edwards depending on position and energy at the time of failure. In any event, he could depend on constant advice from the ground as to the state of the aircraft's energy.

Ground plot of the energy, however, is useful to the pilot only to the point where he intercepts the high key, usually at 20,000 ft. High key is one of two pre-established points in space which give the pilot a go or no-go for a dead stick landing. From this point, any information relayed from ground controllers would suffer from a time lag and rapid "how-goes-it" information is needed instantaneously. In this phase, experience and a nebulous thing called intuition are the most reliable means of calculating the flight path in order to achieve touchdown at a precise point. Judicious use of speed brakes to increase drag and variations in the size of the landing pattern are necessary to bring the powerless research aircraft onto the lake bed at a prescribed landing point.

A new technique, that of energy management, is being developed to predict accurately whether or not a predetermined landing point is within range of an unpowered aircraft.

Energy within the aircraft is directly proportional to the altitude and to the square of the velocity of the vehicle. In the case of the X-15, its ability to glide to a certain point and effect a safe landing is the result of the pilot's ability to trade off the potential and kinetic energy of the craft for range and maneuverability.

Looking down from above, the area into which the X-15 can safely be maneuvered appears as a cardioid generally ahead of the aircraft with the valley of the cardioid closest to the aircraft. It must be noted that because of the X-15's limited maneuverability, the area into which it safely can be landed usually lies ahead of the flight path, and although it expands with increased speed and/or altitude, it also moves out ahead of the craft as the speed increases.



GRAPH SHOWS TYPICAL chordwise temperature gradient for flight at Mach 3. At higher Mach numbers, the characteristic dip in temperature near the ordinates of the graph disappears. Temperature builds up on the leading edge at high speed more rapidly until the curves slope gradually from left to right. Note the temperature gradient on the midspan cross section.

Calculations of the correct energy management techniques are made prior to each flight in the program. Lines representing the nearest point on which a landing can be made are overlaid on a map of the planned mission together with airspeed and altitude points representing minimums which must be attained at certain points.

Present method of information display in the NASA control room is rather cumbersome and requires some interpolation. Soon to be installed is a visual display of energy on a 21-in. screen which will show aircraft position relative to the ground and the possible landing area in the form of a variable-size cardioid superimposed on the ground display. Inputs of aircraft speed and altitude will be fed into a computer and will automatically vary the size of the cardioid. Attitude of the aircraft also affects the size and shape of the display reflecting the lessened range of the aircraft when it is in a steep climb.

Reference to the display scope will enable ground controllers to assess immediately the range potential of the X-15 during all phases of flight beginning with a small cardioid, representing a small energy potential, at the start to a very large area well out ahead of the craft as it reaches speed and altitude

and gradually reducing to zero as the research vehicle comes back to rest on the Edwards dry lake bed.

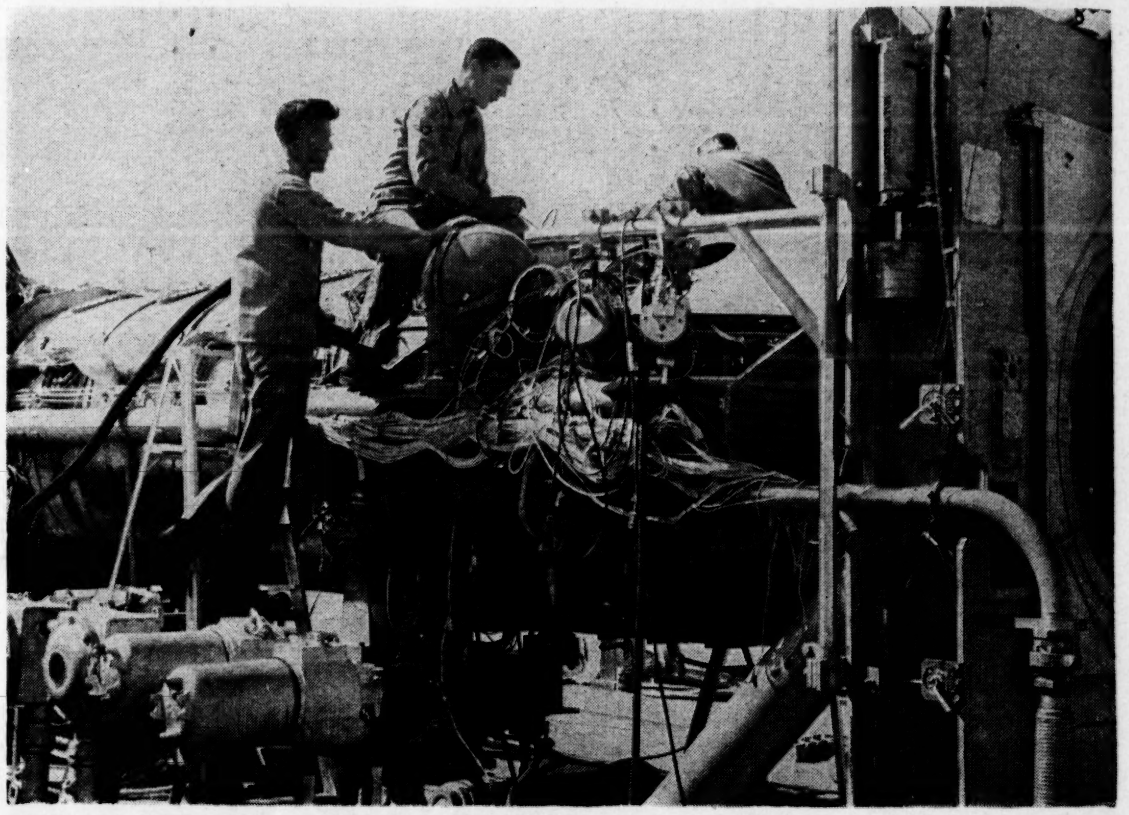
Energy management display has obvious applications to Dyna-Soar because of the problems inherent in recovering such a vehicle from orbital flight. Not only will a display be vital for assisting ground controllers in advising pilots but an airborne cockpit display is deemed necessary.

Such a display, already being worked on, would present to the pilot his present position, the suitable landing sites ahead and a superimposed shape embracing the ground area onto which he could bring the craft for a successful landing. One more task for the X-15 will be to test such an airborne energy management display prior to its installation in Dyna-Soar.

Efficacy of energy management method of landing versus some procedure figured out by a computer and relayed to the pilot is proved by assessing the landings made in the X-15 by the seven pilots. Early in the program, no particular point on the lake was designated for landing but at the suggestion of the pilots, a marker was laid down as the touchdown point. Records have been kept of the landing point distance from this marker and they show that most landings have been within 1,000 ft. of the mark. This is a good performance even for powered aircraft and little short of spectacular for the unpowered, high lift/drag X-15. It points up the usefulness of this recovery technique for application to other spacecraft such as Dyna-Soar and even opens the way for these aircraft to land at bases which may not necessarily have the fortunate geography of Edwards.

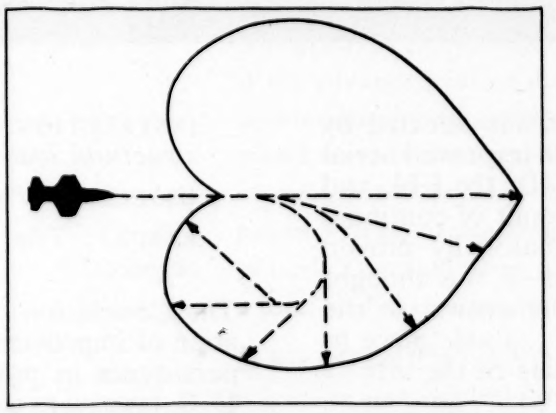
Normal approach pattern speed for the X-15 is 300 kt. and at this speed, White reports that the X-15 has a very "solid" feel. With the flaps and gear up it has about the same glide ratio as an F-104 in landing configuration and pilots have found it helpful to practice approaches in the F-104 at the various emergency landing sites as well as the main recovery spot at Edwards.

Once the aircraft is turned onto final approach, the ventral fin is jettisoned and the flaps extended. Forward speed is traded for flareout ability as the aircraft approaches the ground and once the flare is under way, the landing gear is extended. Average touchdown speed is about 185 kt. and although the aircraft could be landed at a slower speed, it is more or less "spiked" or flown hard on the lake bed to prevent the nose from slamming down too hard. Since a lower speed would result in higher angle at ground contact, this is avoided in order not to exceed structural limits on the fuselage. It is not possible to hold the nose off the ground because the steel skids are aft of the stabilator center of pressure and therefore the stabilator can exert no moment on the tail to hold the nose off. Once the skids touch, the nose comes down and the pilot is powerless to prevent a healthy thump.



THIOKOL 57,000-LB.-THRUST XLR-99RM-1 engine is readied for ground run at Edwards AFB. Delay in development of this engine caused the use of two interim XLR-11-5 16,000-lb.-thrust four-chamber engines early in the program. Engine exploded during ground run in June, 1960, virtually destroying the aft section of the number three X-15 which has been rebuilt but not yet flown. Pilots and engineers report the XLR-99 has performed well on all flights.

An unorthodox method is used for directional control once the craft is on the ground. Ground steering is achieved by lateral displacement of the control stick which causes differential stabilator deflection to impart more or less weight to one or the other of the skids. Therefore, if the aircraft tends to drift toward the right of the rollout, the pilot applies left "aileron" and the rolling tail applies more force to the left skid increasing the friction thereupon and straightening out the roll. This ingenious method of directional control was not thought out until after the first free flight of the X-15.



UNDER HIGH SPEED and/or high altitude conditions, the X-15 can be maneuvered into a landing spot within the area enclosed by the cardioid shape shown here. Note that the aircraft cannot land on a spot directly beneath it. High lift/drag ratio means a large radius turn and aircraft would expend energy too fast to spiral down for a landing directly below. Energy management predicts amount of energy at any given time and advises pilot of situation with reference to intended landing point. Distance from aircraft to nearest point on cardioid is about 25 naut. mi.

(This is the first of two articles on the X-15 research program. The concluding article will appear in a subsequent issue of Aviation Week.)

Foundation Will Study U.S. Scientific Needs

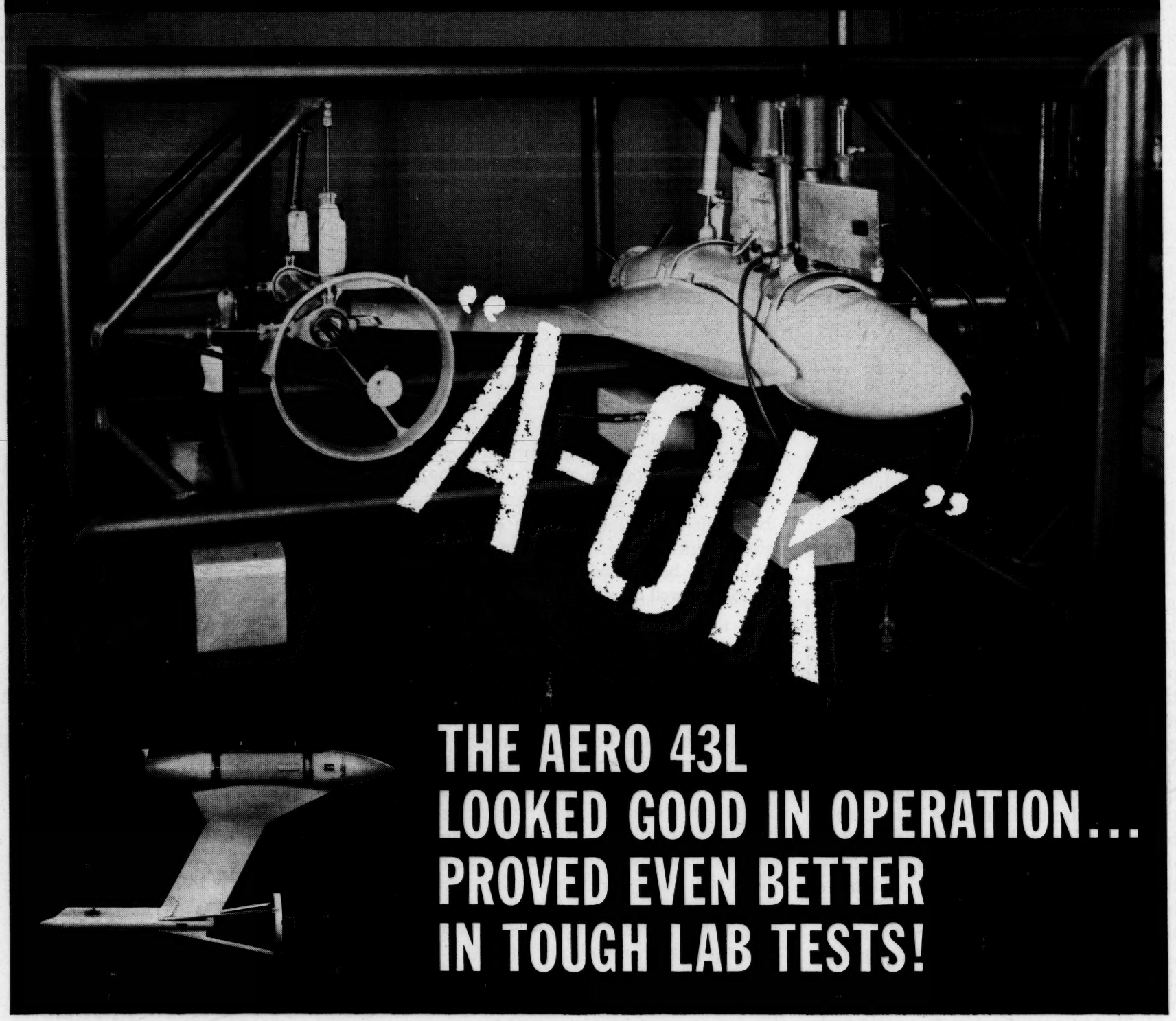
Washington—National Science Foundation has established a new office to analyze trends in scientific resources and to anticipate the effects of massive government programs on long-range scientific needs.

The office, headed by Dr. Richard H. Bolt, is called the Science Resources Planning Office. A foundation spokesman told Aviation Week that formation of the group does not reflect specific concern over the emphasis being given to the Apollo manned lunar landing program, but is an attempt to survey the entire scientific field in research and teaching needs over the next decade.

In addition to the space program, Dr. Bolt's group will survey such areas as oceanographic research and arctic exploration.

Dr. Bolt has taken a leave of absence from the Massachusetts Institute of Technology to become associate foundation director for planning.

The USN Aero 43L reel-launcher proves growth potential of standard basic gear...



THE AERO 43L LOOKED GOOD IN OPERATION... PROVED EVEN BETTER IN TOUGH LAB TESTS!

The Aero 43L combination reel-launcher was selected by the U.S. Navy as the basic component of an improved aerial target system with potential use on the A4D, the FJ4, and the F3H aircraft. The Aero 43L was the result of continual improvement of standard equipment operationally proven over a period of ten years. If it performed—it was thought by BuWeps that it might also be a surefire answer to the Navy's F4H Phantom aerial target needs . . . a safe place to put the taxpayers' money in the present state of the art.

So the CNO asked for action, and the Aero 43L took to the air. It looked good. It behaved well! No basic defects could be discerned in preliminary operations.

But true to its 186 year tradition of leaving nothing to chance, the Navy's equipment watchdogs prudently suggested that what seemed to behave well under favorable field conditions may not always stand up well under the extreme rigors of continued field usage. So the Aero 43L was on its way to a highly reputed independent testing laboratory.

INSTRUCTIONS: *Subject the Aero 43L to the toughest structural load tests ever devised for such equipment.*

OBJECTIVE: *Prove it beyond a doubt—or wash it out.*

RESULT: *The Aero 43L is structurally "A-OK" in all respects!*

The Conclusion: Thanks to BuWeps wise policy of evaluation of improvements to qualified basic gear and its diligent persistence in proving the superiority of such equipment—U. S. taxpayers can rest assured that the operational squadrons of their Navy and Marine Corps will continue to be amongst the best trained, most combat-ready air services of the free world.

The Aero 43L is a product of Del Mar Engineering Laboratories...another development of free enterprise working arm-in-arm with the using services. Write Dept. AW-1585-1.

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INTERNATIONAL AIRPORT
LOS ANGELES 45, CALIF.

U.S. Aerospace Firms Form European Assn.

Paris—Representatives of 30 American aerospace firms in Europe have formed an informal organization known as the U. S. Aerospace Industries in Europe to promote "assistance and support in those areas where mutual and common problems exist." Representation includes airframe, engine and avionic firms.

Spokesman for the organization says one of its major purposes will be to aid and assist new companies in establishing branch offices within Europe, drawing upon the knowledge and past experience of various members. It also hopes to promote closer contact and cooperation between the industry and "European governments and related international organizations."

Executive committee members are Gene Murphy, assistant director of European operations for Republic Aviation Corp., chairman; William Lear, Jr., vice president for international development of Lear, Inc.; Edwinson Robbins, Lockheed Aircraft Corp. deputy director for Europe; Geoffrey Parsons, Jr., Northrop Corp. vice president-Europe, and Armand Courtois, of United Aircraft Corp.

Space Temperature

Los Angeles—Daily temperature variations of 600C have been measured at an altitude of 450 mi. and incorporated in the COSPAR (Committee on Space Research) international standard atmosphere for 1961, Dr. Hilde Kallman-Bijl of Rand Corp. said at the meeting of the National Academy of Sciences, here recently.

Atmospheric density at that altitude is so small that the variation has little effect upon the heat transfer to or from a space vehicle.

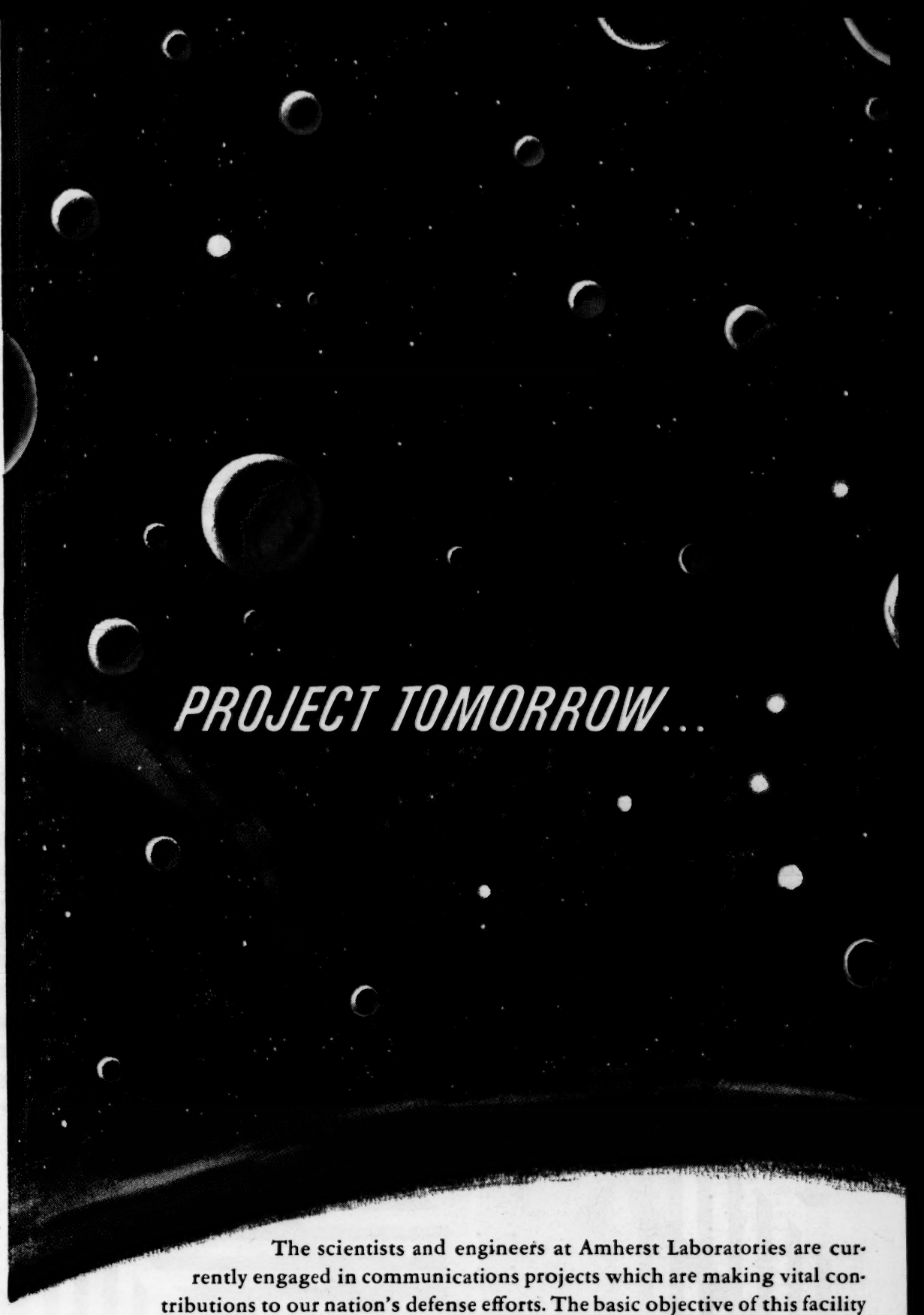
Dr. Kallman told Aviation Week that the important effect of the temperature variation is that it causes the vertical depth of the atmosphere to increase during solar heating and decrease in its absence.

This produces a wide daily variation in atmospheric density at any given altitude and could cause important errors in missile or spacecraft guidance because of incorrect allowances for aerodynamic drag.

It could also produce important errors in the estimated lifetimes of space satellites.

Dr. Kallman said the measurements on which the figures were based were taken in 1958, 1959 and 1960 which were years when relatively high solar activity occurred.

Modifications will probably be made in the future.



The scientists and engineers at Amherst Laboratories are currently engaged in communications projects which are making vital contributions to our nation's defense efforts. The basic objective of this facility is the advancement of the state-of-the-art of communications and instrumentation systems, with emphasis on the role that microwave and millimeter wave technology will play in that advancement. Coupled with these on-going specific projects, is a freedom of investigation that allows no past premise to go unchallenged, allows no new avenues of inquiry to go unexplored. Together, they form what we like to call "Project Tomorrow"... a total dedication to the advancement of the science of communications.

MANAGEMENT AND STAFF OPPORTUNITIES exist for dedicated scientists and engineers with advanced degrees and creative desire. Physicists, Mathematicians and Electronic Engineers are invited to direct inquiries in complete confidence to Mr. H. L. Ackerman, Professional Employment,

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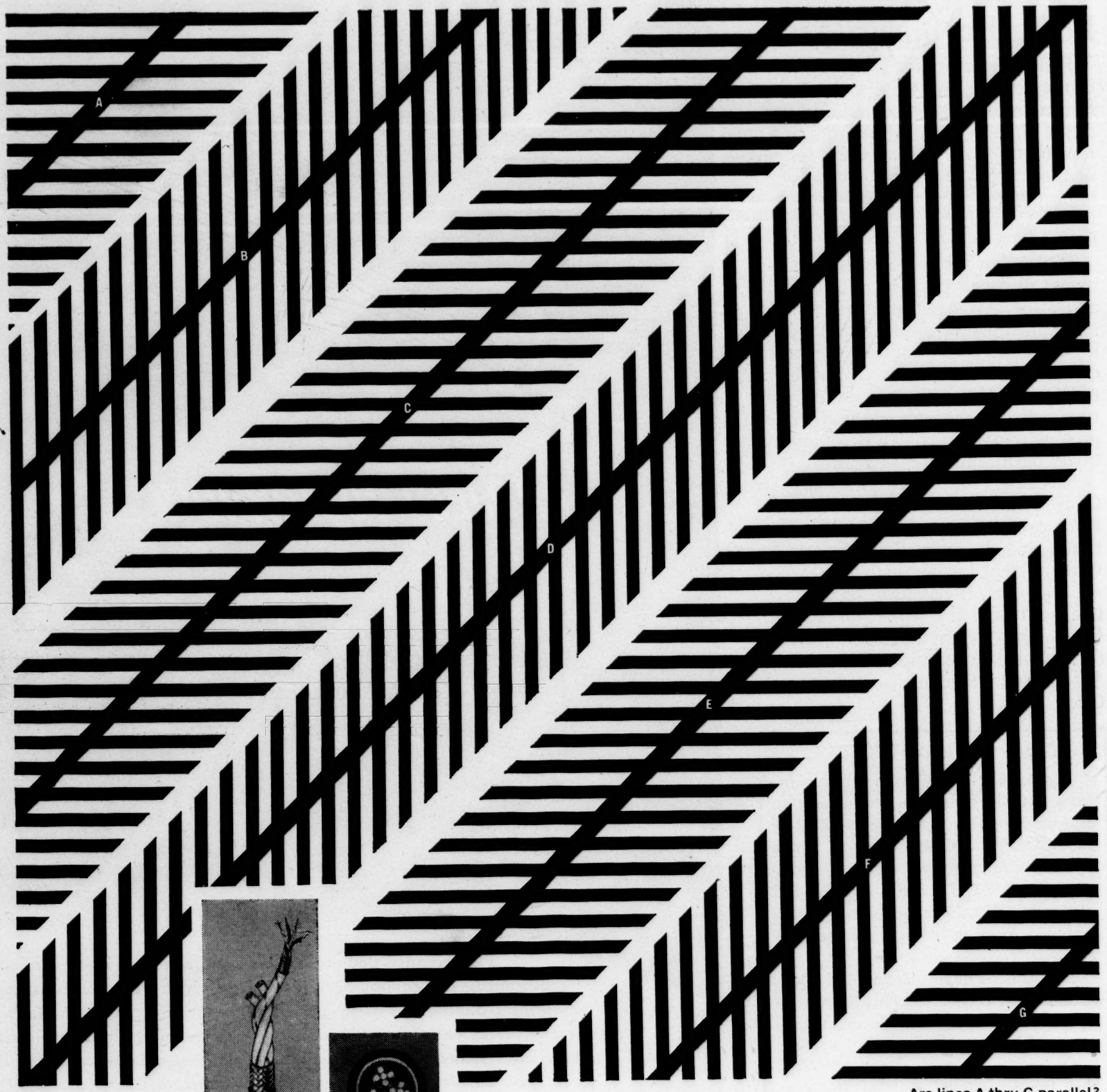
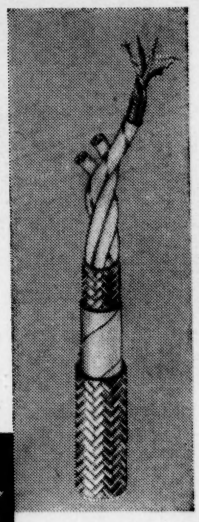
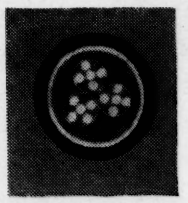
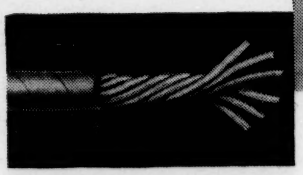
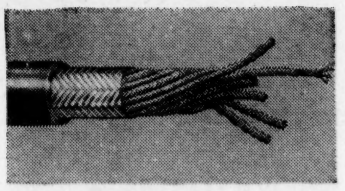


Are lines A thru G parallel?









At Hitemp–Quality is not an illusion

Pick up and examine several different brands of wire and cable. Almost identical, aren't they? Their similarity with regard to quality, however, is just as much an illusion as the art form above.

Although similar materials and equipment may be used in making all brands of wire and cable, one brand—Hitemp—will outlast, outperform the others.

Idle chest thumping? No! Hitemp has the greatest store of experience in the industry—two modern production facilities that are second to none—and more than one-fourth of its entire work force devoted solely to inspection and quality control.

Hitemp products are for you, the wire and cable user who requires quality and reliability that is fact, not illusion.

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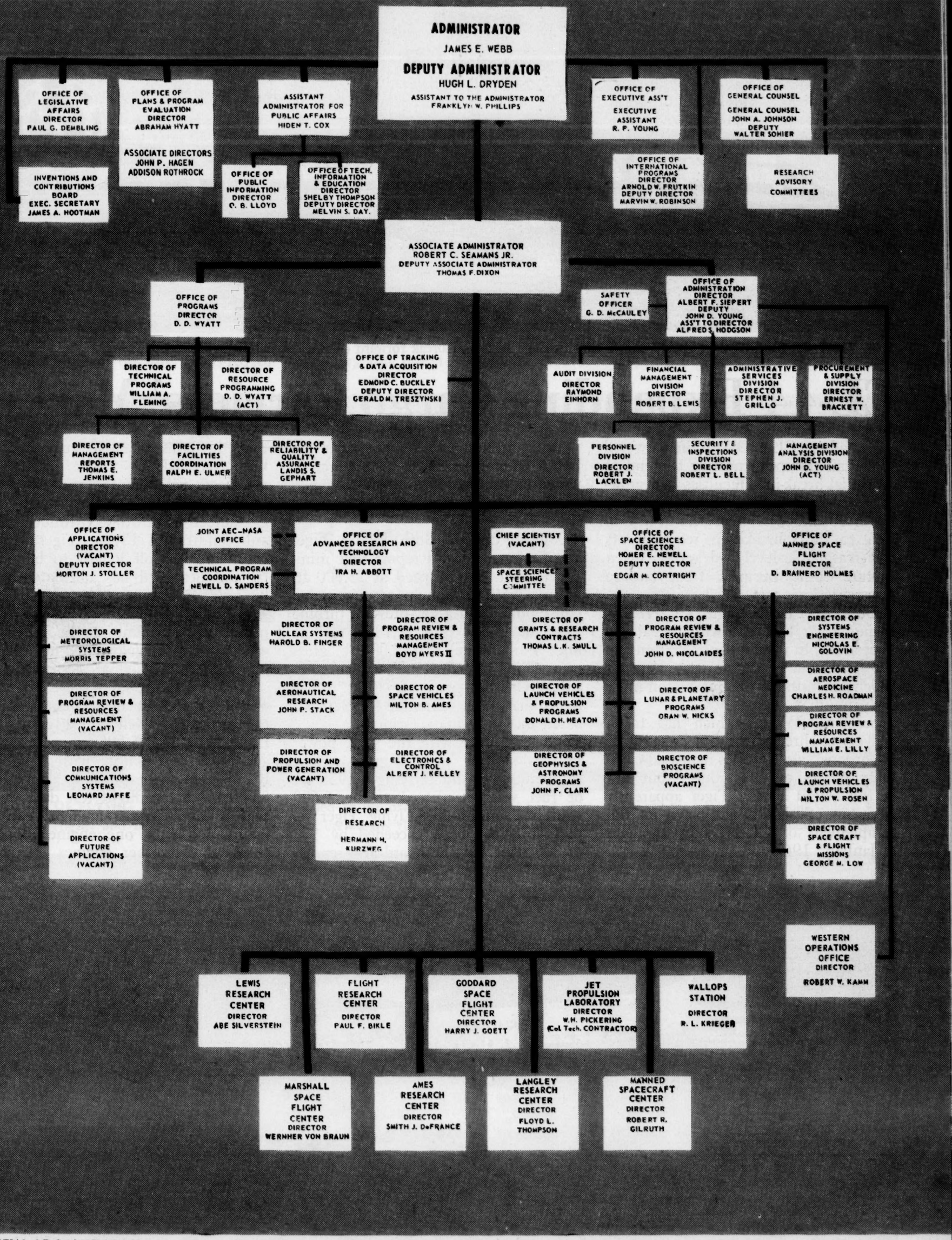


NEW ORGANIZATION went into effect Nov. 1 at NASA (AW Oct. 30, p. 25). Dr. Robert C. Seamans, Jr., became operating chief, basic research projects were shifted to Ira H. Abbott, and mission-oriented projects went to three program offices.

SIDE VIEW OF CL-44D IN FLIGHT shows slim fuselage lines and break forward of vertical stabilizer where tail swings.

CL-44 Expanding Cargo Carriers' Market

Canadair CL-44D turbine-powered swing-tail transport, nearing the end of its initial break-in difficulties and growing pains, may place Flying Tiger Line and Seaboard World Airlines in a position to drop breakeven requirements to a reasonable level and perhaps even capture some business from surface transportation.

Delivery of the last of 10 CL-44Ds to Flying Tiger this year will, the airline hopes, enable it to siphon off some of the long-haul truck freight business which amounts to billions of ton-miles each month.

Seaboard World, which has taken delivery of three of the five CL-44Ds it has ordered, also foresees increased capability on its overseas routes, but not to the extent Flying Tiger apparently envisions. Seaboard will have its full complement of CL-44Ds by the end of January, 1962.

Both airlines mark as plus signs the initial performance of the aircraft, which met or exceeded pre-delivery performance guarantees in these categories:

• **Cruising speed.** Both Flying Tiger and Seaboard World report that minimum flight true airspeed at 25,000 ft. altitude with maximum recommended cruise power and a low-pressure turbine speed of 13,500 rpm. (1,180K turbine inlet temperature) at 172,000 lb. gross weight is 13 kt. better than the guarantee. Cruising speed of 333 kt. is 3% more than the guarantee of 320 kt. based on preliminary estimates.

• **Cruising range** with the same power settings starting with a gross weight of 205,000 lb. and carrying 80,928 lb. of fuel was guaranteed to be 5,600 naut. mi. minimum. Flying Tiger reports this has been exceeded by 5% or 300 naut. mi. Seaboard also reports that the cruising range guarantee has been exceeded.

• **Takeoff field length** required at sea level at 205,000 lb. gross weight was guaranteed to be 7,660 ft. under standard conditions. Flying Tiger reports the actual takeoff length to be 6,980 ft. and Seaboard has calculated it to be 7,100 ft.

• **Maximum landing field length** is reported by both lines to be 6,250 ft., well short of the guaranteed field length of 6,780 ft. needed at a gross weight of 165,000 lb. at sea level.

• **Takeoff performance** from high altitude airports (which only Flying Tiger Line serves) at 205,000 lb. gross weight guaranteed to comply with Civil Air Regulations at a pressure altitude of 8,600 ft. Actual flight test data shows that a 1.6% climb gradient can be maintained with one engine inoperative and the other engines operating

CL-44D IS POWERED by four Rolls-Royce Tyne engines. Bulges forward of horizontal stabilizer house hinges for swing tail.

at 14,500 low-pressure turbine rpm. at 10,800 ft. airport altitude.

Most of the difficulties experienced thus far by the CL-44D have been overcome and Canadair, Ltd., has been "aggressive" in seeking fixes, according to both Flying Tiger and Seaboard.

Engine Removal Rates

Seaboard, which put its first CL-44D in service Aug. 2, has experienced premature engine removal rates of 1.31 per 1,000 hr. engine time in August, when there were two engine failures, and .65 per 1,000 hr. engine time in both September and October when there was one engine failure.

By comparison, Seaboard's premature engine removal rates for the Wright Turbo Compound engines which power its Constellations were .28 per 1,000 hr. engine time for both August and September.

Failure causes on the Rolls-Royce Tynes which have so far been inspected by Seaboard include bleed valve failure, inner shaft bearing failure and propeller shaft seal rub. All engines are reparable.

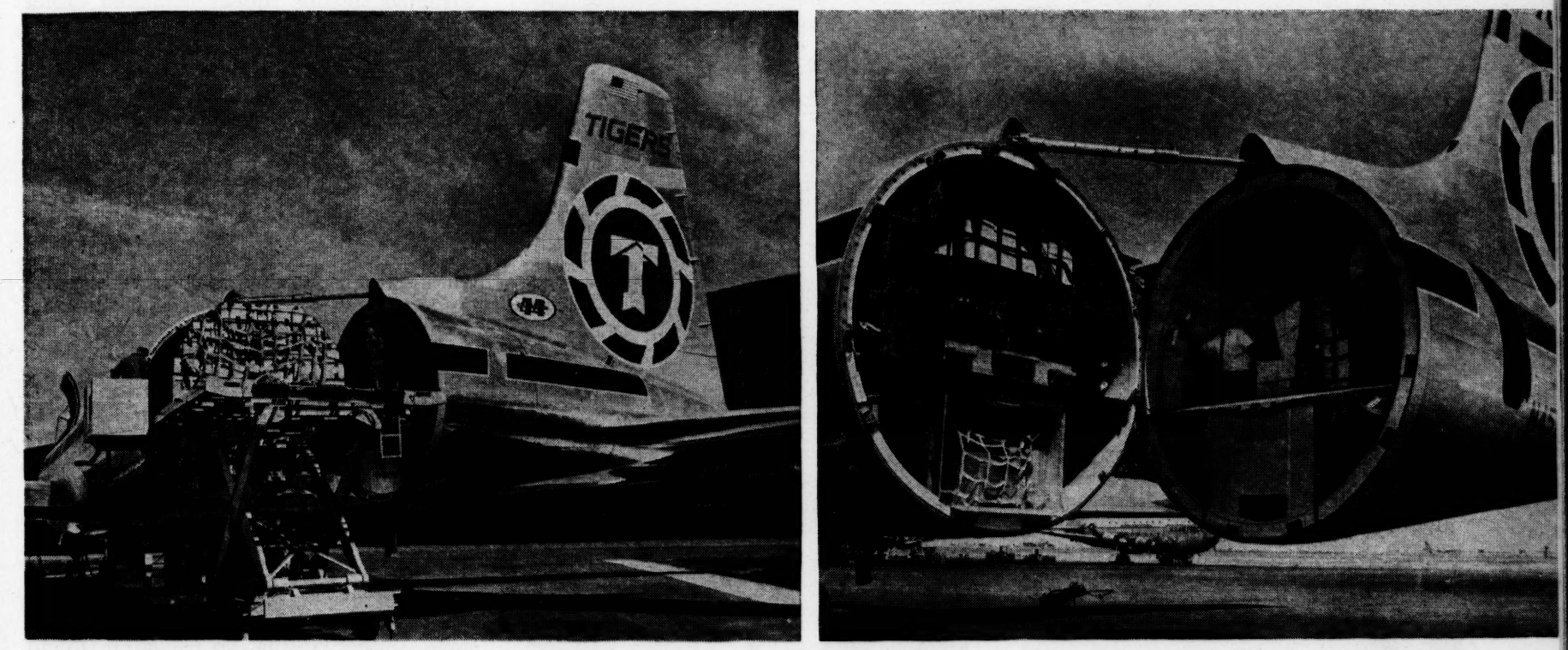
All Seaboard's Tynes are fitted with clutch-mounted rear turbine bearings, which the airline feels have been significant in reducing difficulties with that particular bearing. Most Tyne bearing trouble encountered thus far has been in the rear turbine bearings, but Seaboard so far has not had a malfunction or failure there. The clutch-mounting was recommended by Rolls-Royce as a preventative measure after earlier engines without the mounting began to experience considerable trouble in the bearing.

Flying Tiger recorded an average of one engine failure in 1,926 engine hours in August and one failure in 4,257 engine hours in September. The airline says the rate for October should be superior to the September average. Flying Tiger says the engine failure rate with the Tynes is superior to that experienced during the first 90 days of operating Constellations powered with Wright Turbo Compounds.

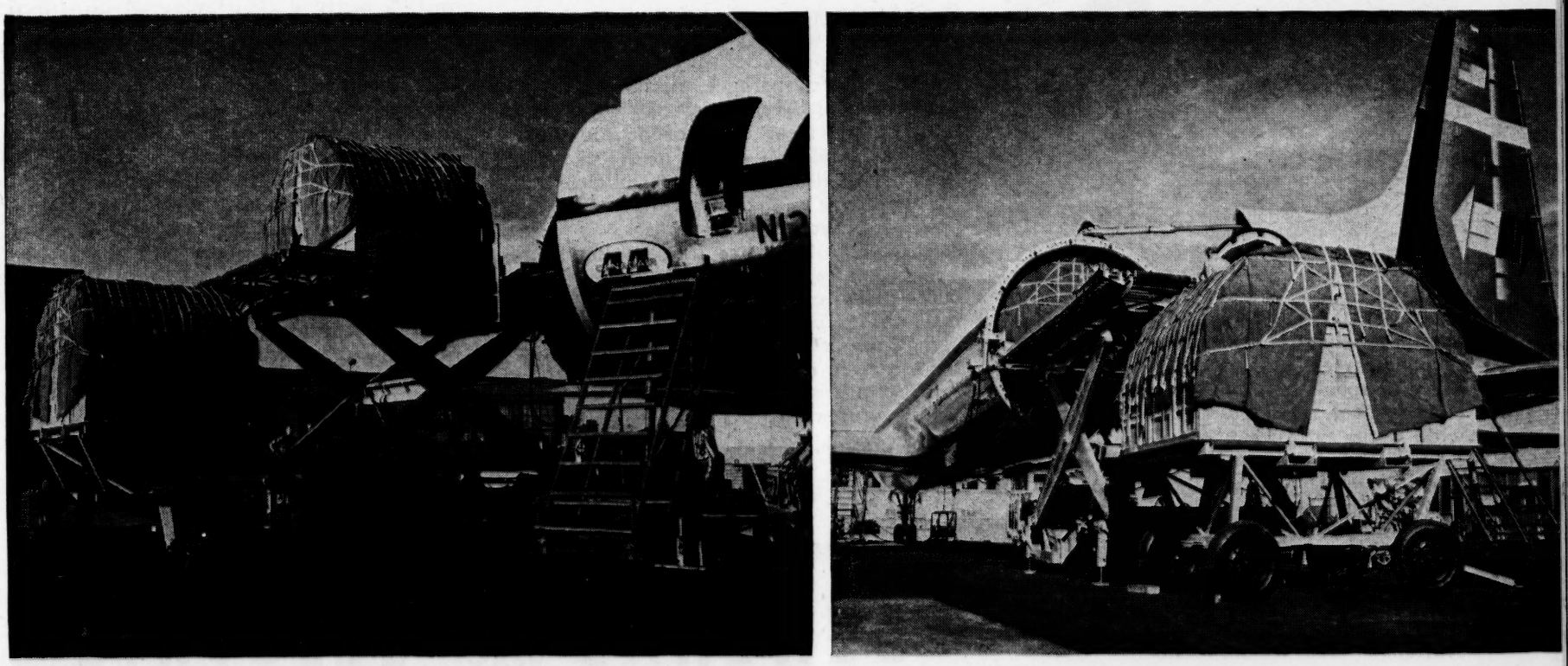
Flying Tiger is having considerable trouble with the aircraft's propeller synchrophasing system which keeps blades in phase with each other so that vibrations are not set up between the propeller blades and the wing or fuselage.

Some persons have gone so far as to blame all the aircraft's troubles on this one system, saying that it has been allowing vibrations to build up which in turn cause other problems. Frank B. Lynott, Flying Tiger vice president-operations, is not convinced, however, and feels that the worst problem poor synchrophasing causes is uncomfortable noise in the cabin.

Flying Tiger reports 54 modifications



LOADING OF FLYING TIGER AIRCRAFT is speeded by use of mechanical pallet hoist. Cargo may also be loaded aboard tail section while it is open (right) and below main deck. Loading crew exits through door visible at extreme right after tail is shut and manually locked.

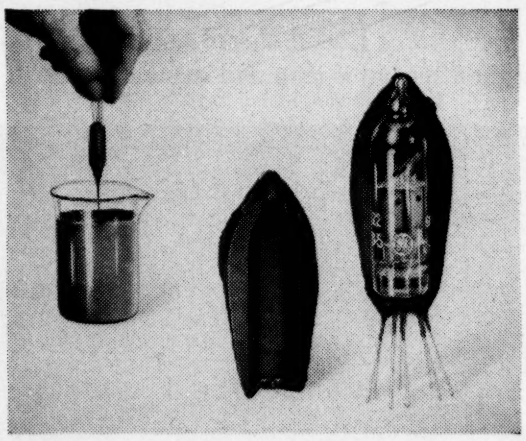


SEABOARD WORLD LOADING SYSTEM is similar to that of Flying Tiger. Pre-loaded pallets are placed aboard carts, towed to aircraft, transferred to loader and hoisted to deck height. Aircraft is ballasted with 10,000 lb. on nose so first pallet aboard doesn't force tail down.

General Electric Silicone Rubber finds dozens of uses in missile systems. How many more will prove vital?

General Electric silicone rubber has the "thermal toughness" to stand up under the searing heat of rocket blast-off or possible atomic attack. Add very good electrical properties and excellent resistance to aging, weathering, moisture, flame, ozone and corona and you can easily see why silicone rubber is now being used in virtually every U.S. missile and space vehicle.

Since both space technology and silicone rubber are relatively new, General Electric believes there are many more areas not yet explored where silicone rubbers can help keep a missile functionally reliable and combat-ready. To help designers in their evaluation work, we list here the principal properties and applications of G-E silicone rubber.



RTV LIQUID SILICONE RUBBER — One of the most versatile materials developed in recent years, RTV is a liquid rubber that cures at room temperatures. Like all silicone rubber, it remains flexible over a wide temperature range and is virtually ageless. Since it comes in a wide range of viscosities, it can be poured, sprayed, dipped, painted or applied with a pressure gun or spatula. It bonds tightly to metal when a primer is used. When not primed, you can readily remove RTV and then reapply more. You can impregnate tightly wound coils with RTV or form sections several inches thick.

You can control cure time from two minutes to 24 hours. These are RTV's typical properties:

Viscosity	from 120 poises (very pourable) to 12,000 poises (paste)
Specific Gravity	1.2 to 1.5
Solids Content	100%
Shrinkage	0.2%
Heat Resistance	from —90°F to 600°F, and as thermal insulation, in 5500°F flame for minutes
Ozone Resistance	Comparable to Mica
Electrical Properties	See last table

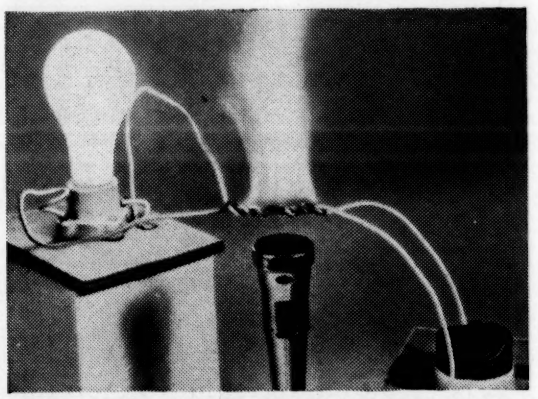
Applications—RTV is used as a high temperature structural sealant in missiles, satellites and space vehicles. It is used to pot and encapsulate electronic components and assemblies for electrical and heat insulation and for protecting delicate components from physical damage. It is commonly used as an impregnating insulation in transformer coils, to pot and hold cable in raceways and to pot cable breakouts. You can make flexible molds with RTV and hence make accurate, duplicate castings from originals.

RTV is an excellent thermal barrier and as such is applied on and around missile nozzles. Tests show RTV's resistance to flame temperatures as high as 5500°F for several minutes. RTV also functions as a flexible ablative material and is used around probe holes, along raceways, and between stages and structural joints on the missile skin.

HEAT CURED SILICONE RUBBER PARTS —Silicone rubber gaskets, port seals, O-rings, shock mounts and other mechanical parts are not only used on missiles but have wide application in ground support equipment. For instance, missile silo doors use silicone rubber seals that will stand up to outside weathering, ozone and abuse for years and which will also resist the heat of missile launching and nuclear attack. Silicone rubber also resists brief exposure to cryogenic materials.

Silicone rubber has long-lasting temperature resistance from —150°F to 600°F, with excellent electrical, weathering, ozone, corona, radiation and nonaging properties at these temperatures. High tensile strength and low compression set are also within its range of desirable properties:

Tensile Strength, psi	800—1500
Elongation, %	100—600
Hardness Durometer (Shore A)	25—80
Compression Set, %	10—80
Tear Resistance lb/in	40—200
Radiation Resistance	1 x 10^8 roentgens
Electrical Properties	See table below



WIRE AND CABLE INSULATION — The long term reliability of silicone rubber when operating in high ambient temperatures and when current over-loads cause the conductor to approach 500°F is an important feature of silicone insulation. In an 1800°F flame, specially constructed silicone rubber insulated cables will continue to insulate for hours, forming a non-conductive ash that gives off no toxic fumes. And short term reliability is obtained even when silicone rubber is exposed momentarily to a direct flame of 5500°F.

Because of this excellent heat resistance, more current can be carried than in conventional cable (or smaller cable can be used). Other features: best compression set of all elastomers at temperature extremes, so that silicone rubber wire and cable does not deform under clamps; high ozone, corona, radiation and weather resistance, low moisture absorption, flexibility down to —100°C. These are the typical properties:

Volume Resistivity	10^{15}—10^{16}
Dielectric Strength, volts/mil	600—650
Dielectric Constant, 60 cps	3.0
Power Factor	.0010—.0050
Radiation Resistance	1 x 10^8 roentgens
Physical properties	Similar to table above.

Applications—Wiring harness made of silicone rubber insulation is often found throughout missiles. Cable offers added reliability for use in various places throughout the launch complex below ground from power plant to silos. All combat vessels built for the U.S. Navy during the last ten years, including fleet ballistic missile submarines and the new nuclear-powered cruiser and aircraft carrier, have silicone rubber insulated cable installations in all fixed wireways. In every case, silicone rubber is chosen because it is virtually non-aging, stands up to intense heat better than any other flexible insulating material, and continues to operate even when subjected to fire.

●

There are many more places where G-E silicone rubbers' inherent properties can be vital in missiles, satellites and space vehicles. For further data, call your nearest G-E sales office or write Section J1133, **Silicone Products Department, General Electric Company, Waterford, New York.**

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either made or outstanding on the CL-44D. Most of these changes are identical with the ones Seaboard has listed on a "hit parade" list of frequent or recurring troubles with its CL-44Ds. Seaboard furnishes a periodic copy of the list to Canadair, Ltd., in Montreal with requests for fixes.

Recent problems have centered around skin and secondary structure cracking in several areas. Cracks have been detected in the aircraft's aileron shroud, in trailing edge wind access doors, in a keel member heat shield located near a jet pipe and along the inboard wing flap shroud. There also have been cracks in the area aft of the outboard engine nacelle, but a beef-up shroud appears to have corrected this.

Seaboard also has been troubled with fuel system problems—notably incorrect or questionable readings from the fuel quantity gages and siphoning of fuel through the outboard wing tank vents. There also were some problems with the fuel dump system. All these problems were nuisances, Jere Farrah, Seaboard chief engineer, explained, and all have been solved. Trouble still is being encountered in the CL-44D's continuous-wire fire detectors, although the high rate of false fire warnings originally experienced has been reduced somewhat by a revised installation.

One of the three Seaboard CL-44Ds operating has been having trouble with the Sundstrand constant speed drive, which has led to some complaints of electrical system troubles by pilots flying that particular aircraft. The problem has not been present in the other two aircraft and Seaboard engineers have tried several fixes which have reduced the trouble.

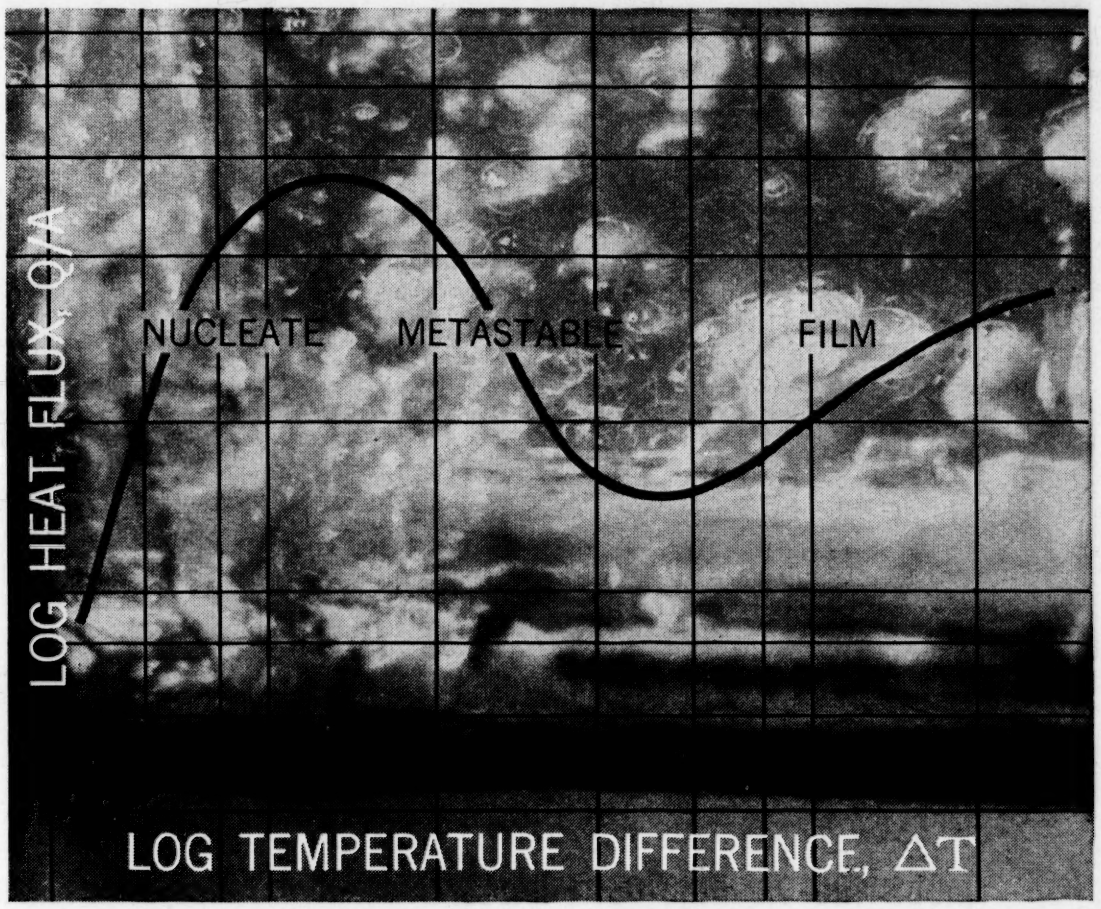
Windshield Failures

Both Flying Tiger and Seaboard have lost windshields because of the failure of landing gear micro switches to open circuits in the electrical heating system of the windshield. Repeated takeoffs and landings caused the oil in the landing gear shock struts to become heated with the result that at light gross weights, such as would be encountered on training flights, the oleos did not compress far enough to allow the micro switches to close. Windshields fractured on the ground when they overheated because the electrical power did not disconnect upon landing.

Flying Tiger also had problems with the connecting plug between the HF radio and the aircraft's electrical system. The trouble was of minor mechanical nature, but caused considerable difficulty before the cause was determined.

Pilots for both Flying Tiger and Seaboard generally are enthusiastic about the handling qualities of the CL-44D. The main complaint so far is that the autopilot is not completely certificated

TECHNICAL ADVANCES FROM BENDIX PIONEER-CENTRAL **CRYOGENICS**



This remarkable photo of liquid nitrogen (–320.4°F.) shows all three boiling modes—nucleate, metastable, and film boiling — on a single surface at a single heat flux.

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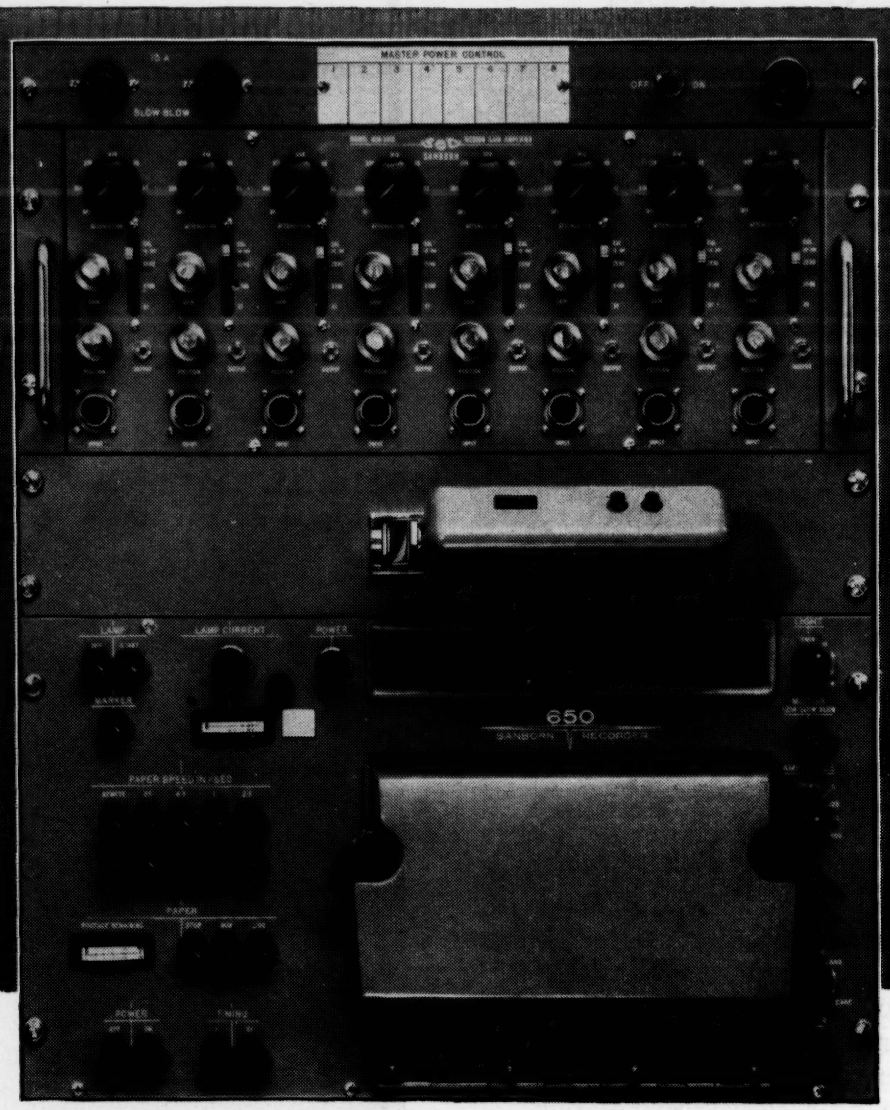

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SENSITIVITY 20 mv input gives 8″ deflection; 12 attenuator steps to X5000, smooth gain control.

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LINEARITY 1½% of full scale (8 in.)

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POWER REQUIREMENTS 103-127 volts, 60 cycle AC; 625 watts

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Here's the *one* system that lets you record inputs from DC to 5 KC within 3 db at 4″ peak-to-peak amplitudes, without changing galvanometers. The "650" system consists of an 8-channel medium gain, general purpose amplifier unit driving a high speed, high resolution optical oscillographic recorder. It can be easily built into your system, packaged in a mobile cabinet or housed in individual cases. The single-chassis, 7″ high amplifier module has 8 separate channels, *complete from floating and guarded inputs to galvanometer outputs;* each channel comprises a front end modulator and input transformer, carrier amplifier, demodulator, filter and driver amplifier. Power Supply and Master Oscillator Power Amplifier are built-in. All amplifier elements are plug-in transistorized units for easy servicing.

Immediately readable recordings are made on 8″ wide daylight-loading ultra-violet-sensitive charts which require no chemical development. Features of the 12¼″ high recorder unit include 9 electrically controlled chart speeds from ¼″ to 100″/sec; calibrated monitoring screen; automatic trace identification and timing lines at 0.01 or 0.1 sec. intervals; amplitude lines spaced 0.1″ apart which can be blanked from ¼, ½, ¾ or all of chart. Recorder is available with an 8-, 16- or 24-channel galvanometer block which is then equipped with the number of galvanometer elements desired by the customer. Both the Recorder and Amplifier are also available as individual units for use with other equipment.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman St., Waltham 54, Massachusetts

and, although installed, is disconnected. Canadair was expected to complete flight tests shortly on the autopilot's reaction to hard-over signals following which the autopilots could be modified and used in flight. Seaboard put its first functional autopilot in operation the first week in November.

Transition time for the Constellation-qualified Flying Tiger crews averages 10-14 hr. or about the same transition time required for the Lockheed Electra. Seaboard was transitioning pilots individually, rather than as part of a crew, and reported about 10-12 hr. per captain required.

Crew training is scheduled to begin later. At the time of this writing, Flying Tiger had transitioned 16 crews into the CL-44, including pilot, copilot, flight engineer and navigator. Total amount of transition training scheduled by Flying Tiger provides for 120 pilots, 60 flight engineers and 40 navigators to be CL-44 qualified.

Unlike domestic passenger-carrying airlines, a certain amount of training can be accomplished on domestic freight flights since, as Flying Tiger Training Director Hal Kolp pointed out, a load of freight doesn't mind if another 10 min. is consumed while the training pilot is conducting ILS or GCA approaches.

Cargo Capacity

Flying Tiger's operations personnel say the Canadair aircraft already has experienced some growth in that gross weight is to be increased to 210,000 lb. with the additional 5,000 lb. going into added fuel capacity. They also expect that cargo capacity may be raised from 65,000 to 70,000 lb. in the near future.

The CL-44D provides Flying Tiger with a tool with which it feels it can compete with surface transportation, primarily transcontinental trucking operations. Present average costs of moving commodities by various means is 35 cents per ton mile for air express, 22 cents per ton mile for air freight, 8 to 9 cents per ton mile for trucks and 5 to 6 cents per ton mile for rail movements.

Range of trucking freight charges is 6 to 14 cents per ton mile and it is the the top third of the truck business which Flying Tiger Line is hoping to capture. Ton mile costs of the CL-44 have proven out in the first few months of operation to where profitable operation can be maintained at 13.5 cents per ton mile, Tiger President Robert W. Prescott contends.

Certain bulk items now shipped by truck at the lowest rate are not attractive items for air cargo. Cargo at the low end of the truck rate from 6 to 10 cents per ton mile is not what the cargo line is after. But the items on the high end, from 11 to 14 cents per ton mile, can be hauled by air on a competitive rate basis so long as the average freight revenue per flight comes out to more than 13.5 cents per ton mile.

Not only can the line offer service on a competitive rate basis, but the extra speed of air freight, overnight coast-to-coast movement versus 10 days by surface, is available without extra charge.

Business Potential

Just how much is the potential of this business was revealed in a survey Flying Tiger conducted recently. Over one route where freight was moved more than 700 mi., 40 billion ton miles of freight were being carried each month by surface transportation at or above eight cents per ton mile. Even a small fraction of this volume would cause a great rise in air freight shipments, which now average 12 million ton miles per month for all domestic air cargo carriers. Realization of this potential was enough to cause Flying Tiger to suspend the study and launch a sales campaign aimed at capturing some portion of the market.

By the end of October, half of the 10 aircraft ordered by Flying Tiger at a cost of $55 million had been received. The sixth aircraft will be delivered this month and all 10 will be delivered by the end of the year. Originally, delivery was to have been completed by the end of October, but this schedule was delayed when some fixes were cranked into the production line. Flying Tiger decided to take delivery of the sixth airplane without waiting for incorporation of all fixes.

The first aircraft was delivered to Burbank, Calif., in early June and crew training commenced immediately so that by July 1 the line was able to fulfill its promise to the Military Air Transport Service and begin passenger service to Tokyo. The first flight carried a double crew, plus 142 passengers. The round trip from San Francisco to Tokyo was made in less than 48 hr. total elapsed time. When all 10 aircraft are delivered, six will be assigned to domestic freight operations and four to fulfill MATS contracts on transpacific passenger and freight routes.

CL-44D Vs. L-1049

Lynott figures that the CL-44D is about five times as productive as the Lockheed 1049 Super Constellations which the line has been operating. The reasoning behind this takes into consideration these factors:

• **Payload of the CL-44D** is 65,000 lb. vs. 45,000 lb. for the L-1049. On one round trip to Tokyo, the CL-44 will generate 358,000 ton miles of capacity,

PUMP PRIMERS

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BETTER PUMP RELIABILITY IN SEVERE ENVIRONMENTS

► Engineers concerned with drives, auxiliary power sources, gear boxes and various transmission design problems involving pressure lubrication have found Gerotor type pumps extremely useful in their attempts to hold weight down and achieve maximum compactness with high service reliability.

► **These pumps are positive displacement types inherently simple, valveless, balanced and quiet. In severe environments they prove exceptionally reliable.**

► The Gerotor is a form of internal gear pump consisting of only two moving parts: an inner toothed element and an outer, meshing toothed element. The inner element has one less tooth than the outer and the "missing tooth" provides a chamber to move the fluid from the inlet port to the outlet. (See Figure 1). Pump capacity is measured by the volume of the "missing tooth" multiplied by the number of driver teeth and RPM.

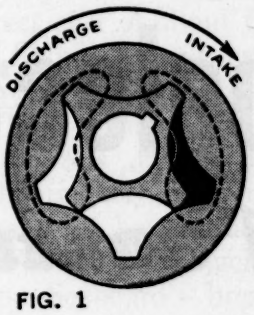

FIG. 1

► **Low relative speed and closely held clearances between the two Gerotor elements mean high mechanical efficiency is maintained.**

► Slow opening of the chamber as it traverses the large inlet and discharge ports results in avoidance of the sudden shock, rapid pressure change and turbulence which, in other types of pumps, results in foaming and lowered efficiency. Thus, Gerotor pumps offer exceptionally good performance at high altitude.

► **Engineers find the Gerotor pump most attractive because there are several convenient variables that can be adjusted to meet the application requirements: Gerotor *diameter* which governs the area of the pumping chamber, Gerotor *thickness*, which, taken with area, determines *unit volume* per revolution and *R.P.M.* Thus, it is possible to vary the diameter, length and speed of the pump elements to secure wanted capacity. In addition, the porting of this type of pump is completely flexible in location, making for ease of fitting, adaptability to the available space and geometry of the engine structure.**

► *Technical data is available and your inquiry is invited. Write:*

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Power Drain	2-4 mw @ 3 volts
Fan-Out (TI SN 510, 512, 514, 515)	4
Fan-Out (TI SN 511, 513)	20
Propagation Delay	75 to 450 nsec
Power Supply	3 to 6 volts
Temperature Range	−55° to +125°C

UNIT	TI SN 510	TI SN 511	TI SN 512	TI SN 513	TI SN 514	TI SN 515
FUNCTION	Flip Flop, Counter	Flip Flop with emitter follower output	NOR/NAND Gate (6 input)	NOR/NAND Gate (6 input) with emitter follower output	Two NOR/NAND Gates (3 inputs each)	Exclusive OR
	Clock pulse is internally capacitive-coupled					

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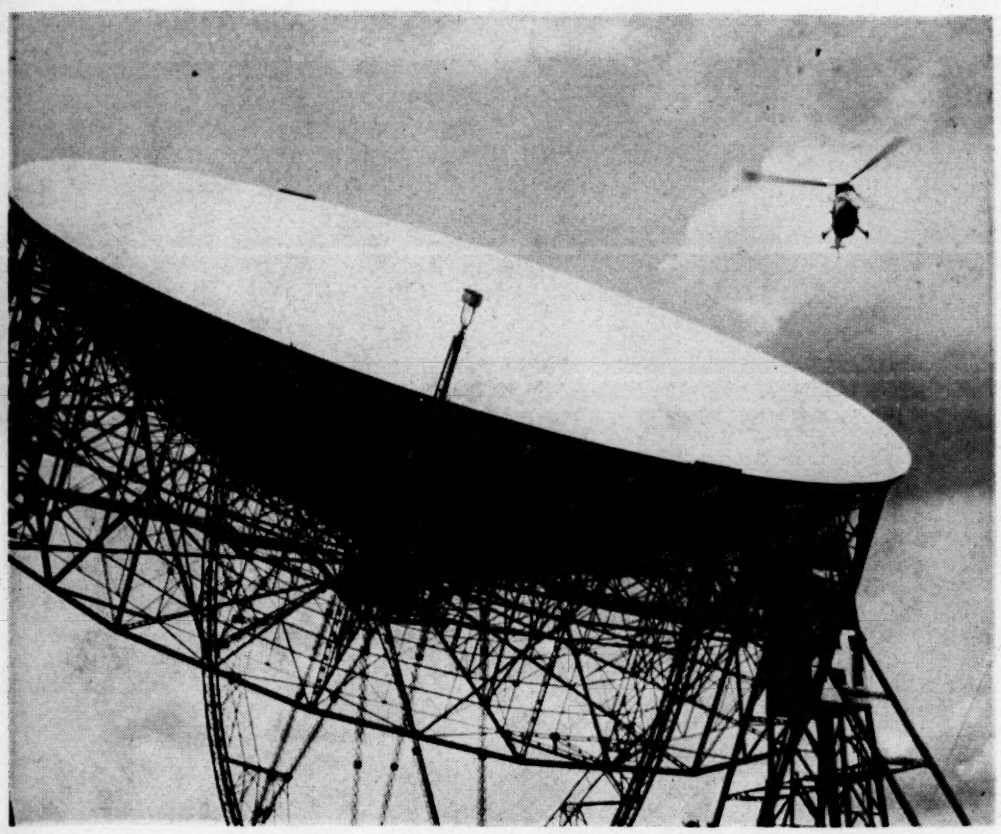


Helicopter Lifts Transmitter From Radio Telescope

Westland Whirlwind helicopter, flown by Test Pilot John Fay, lifts a 10-kw. transmitter out of the 250 ft. dia. radio telescope at Jodrell Bank, England. Transmitter, used in satellite tracking, weighed 350 lb. and was lifted free on a 100 ft. line. The operation took 8 min.

as opposed to the 248,000 ton miles generated by the older, piston-powered aircraft.

• **Speed advantage** of 100 mph. enjoyed by the CL-44D makes it possible to schedule it for three round trips per week against two per week for the Constellations. Therefore, a CL-44D can generate 1,074,000 ton miles per week vs. 496,000 ton miles per week for the 1049, an increase by a factor of 2.16 in available ton miles.

• **Operating costs** of the CL-44 are less than half those of the older aircraft. Direct operating cost of the CL-44D is proving to be four cents per ton mile vs. nine cents for the Constellation, a decrease by a factor of 2.25. Indirect operating costs also show a similar cost reduction factor.

• **Total effect** is that the increased ton mileage capacity multiplied by the decreased cost factor equals a 4.88 productivity increase factor.

Increased productivity of the turboprop air freighter operating at a lower ton mile cost than previous aircraft used by Flying Tiger enabled that line recently to file a new cargo tariff with the Civil Aeronautics Board which provides for an over-all lowering of rates on several hundred items from a general average of about 18.5 cents per ton mile to 13.5 cents per ton mile (AW Oct. 2, p. 45).

The introduction of CL-44Ds on domestic freight runs will cause an increase in the amount of available ton miles flown daily which might have been hard to fill immediately. The more-than-double cargo capacity owing to greater payload and increased speed could possibly have gone begging until sales could have been increased. However, the carrier has no such surplus of capability at present, mainly because the Berlin crisis has forced the military services to press every cargo aircraft into service.

Disposal of the 12 Constellations Flying Tiger now operates is not likely to occur until either the military has fulfilled its needs in shipping high-priority freight overseas or until the tension over Berlin has subsided. Once the situation settles down, whether or not the Tigers can keep the new cargo craft filled depends on how effectively they skim off a part of the billions of ton miles of revenue freight now carried by the trucking industry. Tiger officials are confident that this will be accomplished and new business will come to the line not by being lured away from other air freight lines, but by being attracted to air cargo from surface shipping.

Seaboard tends to take a considerably more conservative point of view than does Flying Tiger when forecasting the economic benefits that will result from the CL-44D.

Seaboard President Richard M. Jackson feels that Flying Tiger's estimate of a productive capacity of the CL-44D nearly five times greater than that of the L-1049 is a considerable over-estimation. He said that Seaboard believes that the CL-44D has about 240% of the productive capacity of the Constellation and that, as a rule of thumb, Seaboard will figure a CL-44D to have double the commercial capacity of an L-1049.

He estimates that the total fully-allocated cost per ton-mile of the CL-44D will be about 12 cents and the direct cost of about 6 cents, in contrast to Flying Tiger's estimate of 4 cents per ton-mile direct operating cost.

This estimate, he said, is based on Seaboard's target utilization rate of 9 hr. per day, as compared with Flying Tiger's 16 hr. per day utilization target.

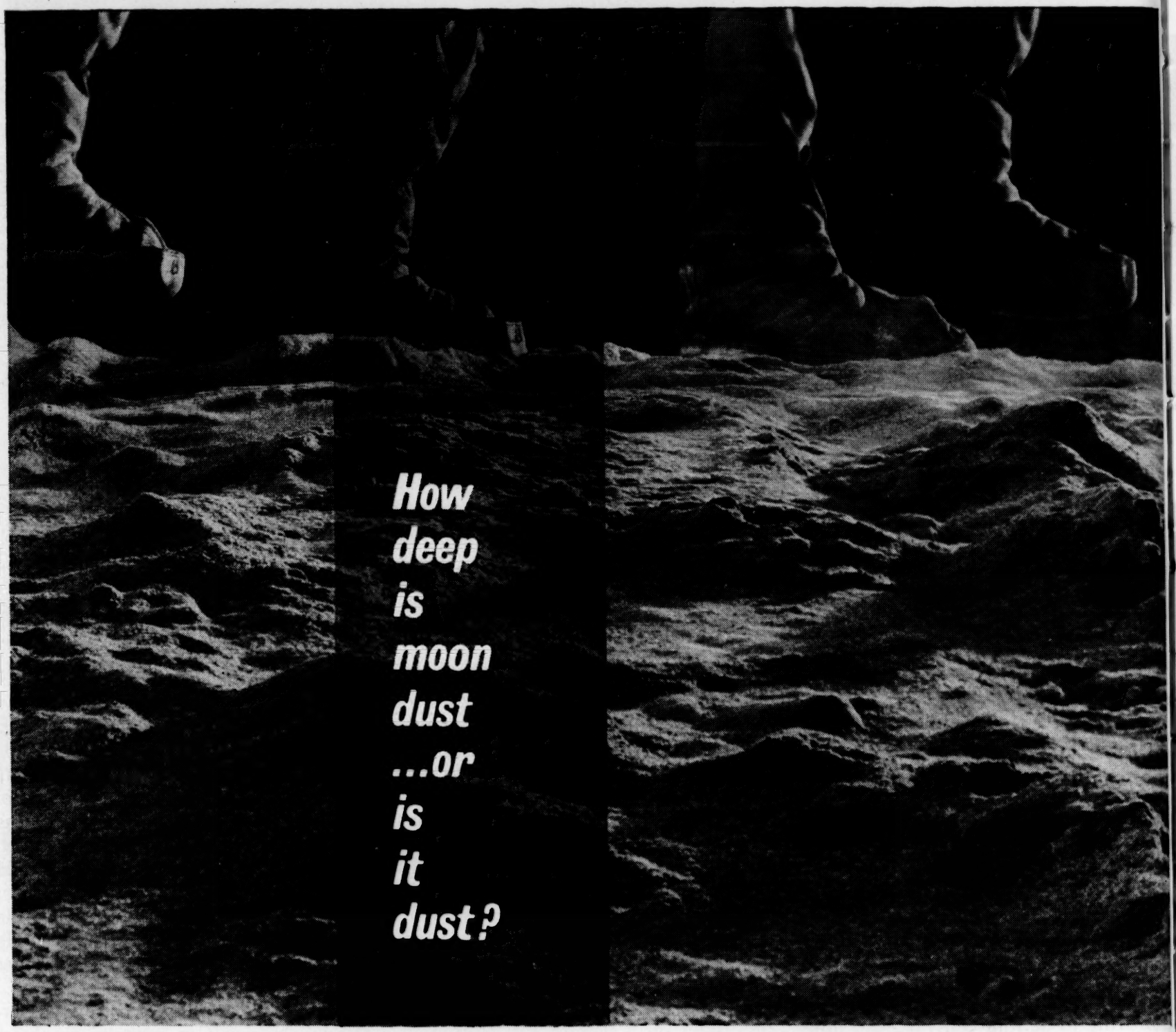
The CL-44D, Jackson added, should drop Seaboard's breakeven load factor to about 75 to 80% as opposed to the 99% plus for the Constellation. He expects a yield of about 20 cents per ton-mile from the CL-44D.

The five CL-44Ds Seaboard will operate will be equal in capacity to about 13 L-1049 Constellations, Jackson said. The cost per airplane trip will be about the same as for the Constellations, he said, but the capacity will be about double.

Because of Seaboard's all-foreign route structure, which makes it more of a point-to-point operation than that of Flying Tiger, Jackson does not think the CL-44D's swing-tail and straight-in loading will be as much of an advantage for Seaboard as for Flying Tiger.

He pointed out that by far the majority of Seaboard's flights are from New York to a single point in Europe and that, on arrival, the aircraft must be serviced, an operation that normally takes longer than the standard unloading/loading time. Consequently, he pointed out, there is no point in racing to unload and load the aircraft in minimum time.

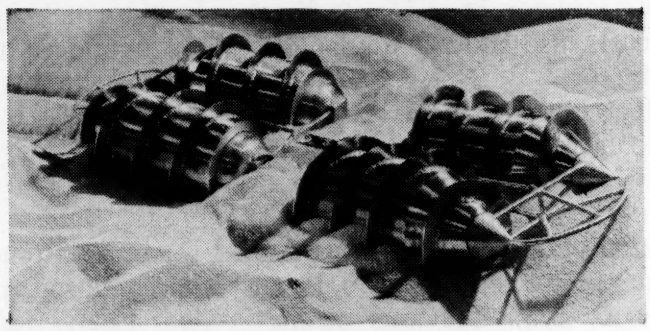
Flying Tiger routes, he said, may allow a fully-loaded CL-44D to leave Los Angeles for New York via Chicago, where cargo will be off-loaded and different cargo loaded for the balance of



GM's DSD seeks an answer!

Scientific studies are now under way in GM's Defense Systems Division to determine the most efficient configurations for lunar-roving vehicles. Major factors under investigation include composition of the lunar surface together with the effects of large temperature ranges, lunar gravity . . . no atmosphere or humidity. Research in our Soils Laboratory on probable lunar conditions has led to a number of promising designs. Unusual studies like these, unusual facilities and unusually capable men present a great challenge and opportunity to scientists and engineers who are qualified to make a solid contribution at any level. DSD is now, as always, searching for new talent in these areas.

Scientific areas now under study: ▪ Aero-Space Operations ▪ Sea Operations ▪ Land Operations ▪ Biological Systems ▪ Technical Specialties



Moon-Roving Concept—This early model moon rover utilizes the principle of the Archimedes screw . . . and is just one of a number of vehicle types under study for known lunar conditions.

GENERAL MOTORS

DEFENSE SYSTEMS DIVISION

DEFENSE SYSTEMS DIVISION OF GENERAL MOTORS CORPORATION • WARREN, MICHIGAN AND SANTA BARBARA, CALIFORNIA

the trip. Only a minimum of service work would be done there, however, and unloading and loading in a minimum of time is an economic necessity.

Unlike Flying Tiger, Seaboard plans no specific division of aircraft use between commercial carriage and MATS contract work. All five will be assigned to commercial work and diverted as needed to fulfill MATS requirements. At present, two of the three aircraft Seaboard has are being flown in MATS service, with the third used as a backup plane and for crew training.

Since all Seaboard rates are controlled by IATA, Jackson does not foresee a reduction in user costs due to introduction of the CL-44D on the North Atlantic. He does feel, however, that air cargo's two main selling points regardless of the type of aircraft used will be price plus speed.

Many items not previously adaptable to movement by air now can be handled by the CL-44D because of the large cubic capacity available and the access to the cabin afforded by the electro-hydraulically-actuated swing tail, Flying Tiger feels. Time studies show that the aircraft can be positioned, the crew deplaned and the swing tail opened in 6.6 min.

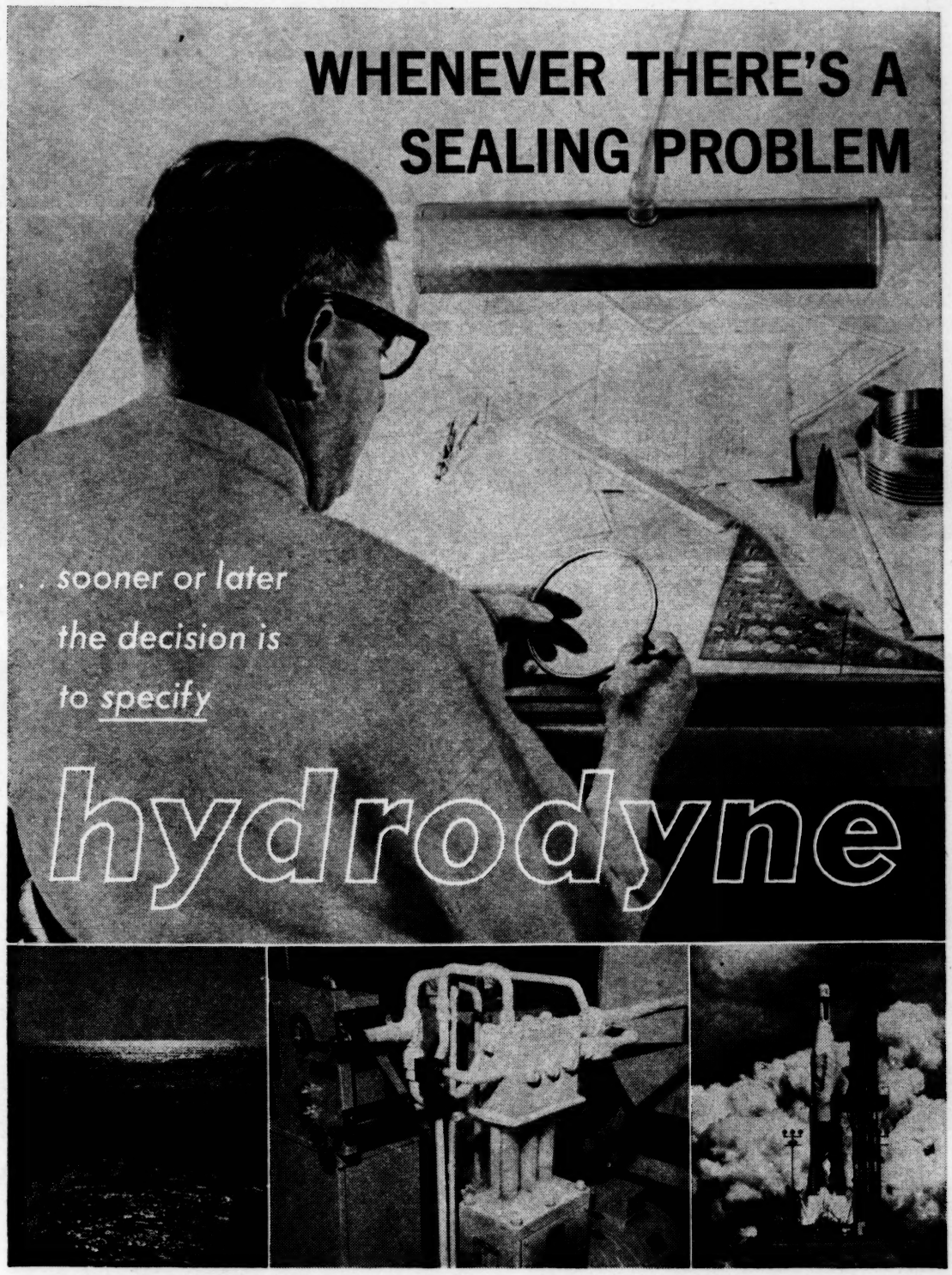
Seaboard expects eventually to reduce total loading time, including positioning, opening the tail, loading and sealing the tail, to approximately 45 min.

Cargo Compartments

Opening the tail exposes the main cargo compartment, the aft underfloor bay and the swing tail compartment. The main compartment is circumferentially slightly greater than a semicircle and is 84 ft. long. Maximum height is 6 ft. 9.5 in. and maximum width is 11 ft. 5 in. Total cubic capacity of the main compartment is 5,528 cu. ft. The two underfloor compartments, one forward of the wing spar and one aft, are 35 ft. 11 in. and 38 ft. 6 in. long and measure 523 cu. ft. and 586 cu. ft. respectively. The tail compartment contains 711 cu. ft. of usable space and has a maximum capacity of 3,000 lb. which can be loaded while the tail is open. Total floor area available is 1,387 sq. ft. and the total volume is 7,348 cu. ft.

Capacity of the CL-44D makes it possible for Flying Tiger and Seaboard to consider cargo which previously could not be carried because of the lack of straight-in loading accommodations. Because of this, they may obtain some business previously not sought.

For a starter, Flying Tiger recently hauled two Lockheed F-104Gs to Germany in one CL-44D. Although the loading tolerance was barely an inch between the cargo and the aircraft fuselage, the line's ground operations personnel managed to load the two F-104s, complete with installed engines



For the different fluid environmental problems of humidity, oxides, chemicals, temperature extremes, high pressure

Hydrodyne's seals are truly the seals of the nuclear and space age. All metal (precision-machined nickel alloys) to withstand corrosive liquids and extreme heat and pressures — they are flexible, nonmagnetic, and lightweight, too.

But most importantly, the sealing action is *positive*, and remains so, even after continued used in environments that would make other types of sealing devices ineffective. Rugged Hydrodyne static seals are designed to withstand pressures up to 15,000 psi, temperatures up to 2000°F and down to —420°F.

Hydrodyne standard seals are available in sizes from ¼" to 30". Custom types, including nonmetallic coatings and exotic materials, also available. Write for details.

CROSS SECTION

Because of the exclusive patented configuration, Hydrodyne seals — regardless of pressure or temperature — always hold a positive spring-tight flat metal surface against the mating surface. Never an angle or an edge.

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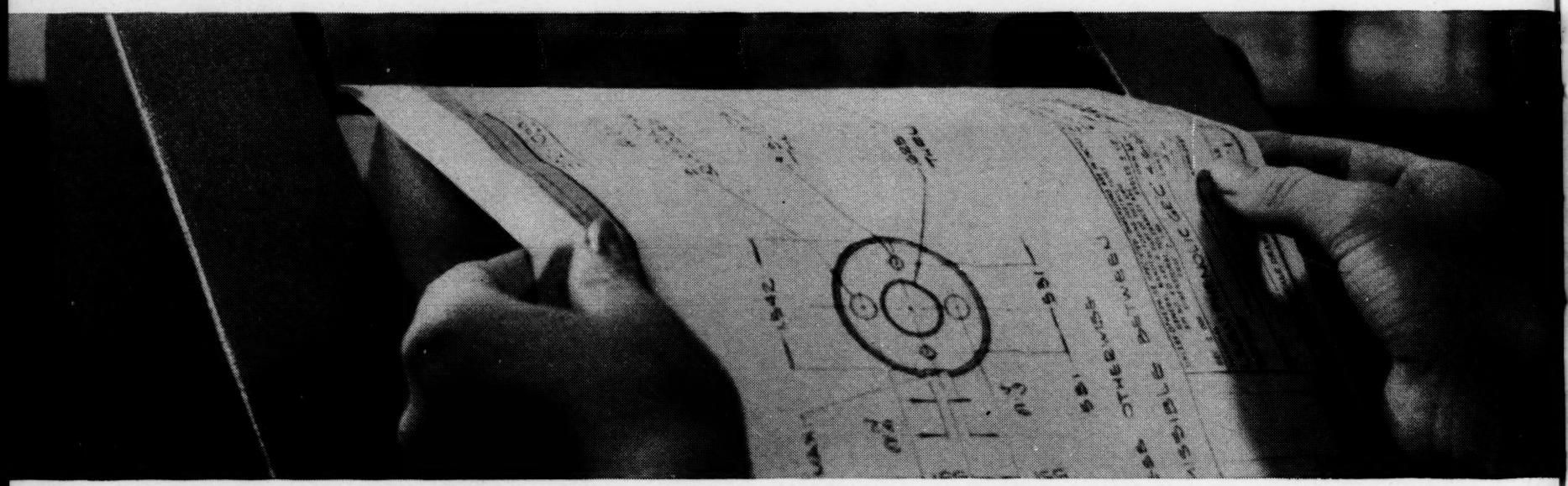

To receive it by SCAN-A-FAX: 3 MINUTES

Fairchild's new facsimile transmission system is a fast, economical way for businessmen to communicate graphic data

HOW COMPANIES CAN USE SCAN-A-FAX: Imagine being in your New York office and receiving a copy of a blueprint just three minutes after requesting it from your engineering department in Sacramento. That's the kind of information exchange you can get with Scan-A-Fax, the new transistorized facsimile transmission system from Fairchild. Financial departments can use it for transmitting financial statements, credit clearances, receipt statements. Engineers can exchange copies of schematics, drawings, graphs. Almost every department can find many uses for Scan-A-Fax.

HOW RELIABLE IS SCAN-A-FAX? Both the scanner-transmitter and recorder are completely transistorized. Because little or no heat is generated, you can operate the system for 24 hours a day, 7 days a week. Advanced engineering in Scan-A-Fax gives you greater resolution than ever available before on comparable facsimile equipment. It easily records up to nine tones of a photographic grey scale.

MORE INFORMATION IS AVAILABLE: One of our facsimile analysts will be happy to survey your company to determine the arrangement that is most efficient and economical for you. Or write us for a copy of: "To Deliver the Facts...Fast."

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and four external tanks per aircraft.

The F-104s were mounted on metal frames with wings and tail surfaces removed. Although the initial loading took less than an hour, final positioning of the load within the cabin was not accomplished until about 8 hr. later. Now that the first loading of F-104s has been accomplished, subsequent loadings will be made more rapidly because the major problems have been solved. The cargo line hopes for a contract to air ship all Lockheed-built F-104s to Germany and Japan.

Again, this is an area where Seaboard's economic views are different from those of Flying Tiger. Jackson feels that while there may be a few items which can now be transported by air because of the swing-tail loading, they are few in number and totally insignificant economically.

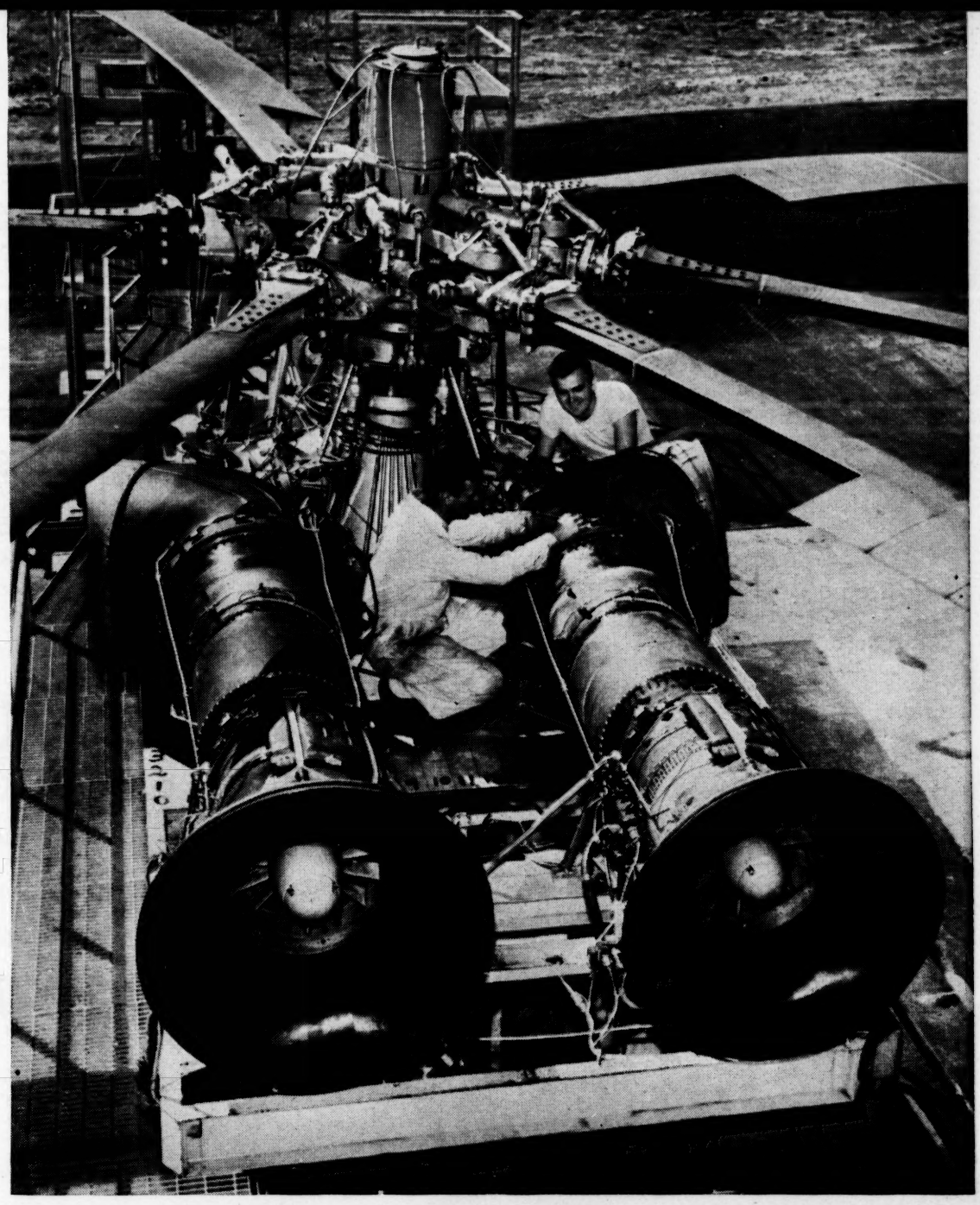
Jackson said he believes that no cargo airline can hope to make money on sustained carriage of outsize cargo because there just isn't that much of it available. He termed the F-104 a "real freak" as far as air shipment of large items is concerned.

Turnaround Time

A reduction in the present turnaround time of 5 to 5½ hr. will be possible with unit loading systems both airlines plan on introducing. Seaboard's system, using loaders built by Houston Fearless Corp. is expected to be fully operational by the end of the year. One of the loaders now is at Montreal for acceptance tests and the others are built and at the factory. Seaboard also has nine rear sill extension loaders, designed for use at stations where cargo volume is not heavy enough to justify one of the larger loaders.

Flying Tiger's system, which is company-developed and somewhat different from that used by Seaboard, will be in operation in January, 1962 (AW Nov. 7, 1960, p. 49). With it, Flying Tiger hopes to be able to park, refuel, unload and load a CL-44D completely in less than 1 hr. 10 min. This, the airline feels, will make possible an ultimate daily utilization of 16 hr.

Some of the 157 pallets needed for the Flying Tiger system have been built. The pallets weigh 137 lb., cost about $430 to manufacture and are sized so that 10 will fit into the main cargo compartment of the CL-44D. The bottom of each pallet is fitted with a smooth abrasion-free strip which will slide over rails imbedded in the floor. Receptacles along each side of the pallet receive cable-driven dogs which engage the pallet and slide it forward in the cabin. A net is lashed over the top of each load to securely bind the cargo to the pallet, which, in turn, is anchored to the cabin floor.



Sikorsky S-64 Rotor System Tested

Rotor system for the Sikorsky S-64 Skycrane helicopter is static tested with the Pratt & Whitney Aircraft JFTD-12 free turbine version of the JT12 engine. System is a 6-bladed version of the Sikorsky S-56 dynamic components. Rotor hub design, except for addition of an S-61 type damper and controls and swash plate for six blades, is the same. Principal modification is in the transmission, which unlike the S-56 receives power input at a 90 deg. angle to the gearbox. This required careful tooth design of the pinion gearing, which must turn at the engine speed of 9,000 rpm., raising a problem of maintaining lubrication. Any lubrication problem was expected to arise early in the testing, and the system has now run approximately 50 hr. without one.

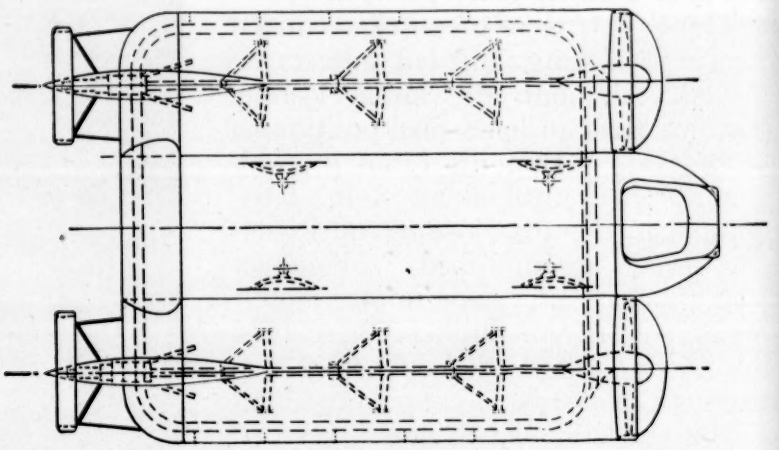
Pallets will be preloaded in the dock area which has a fuselage cross section to serve as a template. A record will be kept of the weight of each package and the entire palletized unit will be weighed as it is picked up by the unit loader. A net of nylon straps keeps the individual parcels secured to the pallet.

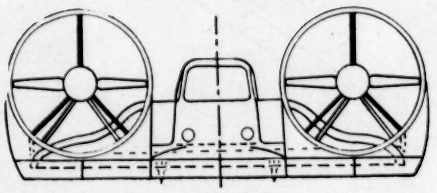
Main reason for going to the unit loader, according to Flying Tiger Ground Operations Manager Joe Healy, is that 93% of the cargo carried by the line is in cartons weighing less than 100 lb., with the average carton weighing 27 lb. Healy says that the optimum package for air cargo is in a non-crushable container weighing 13 lb. per cu. ft.

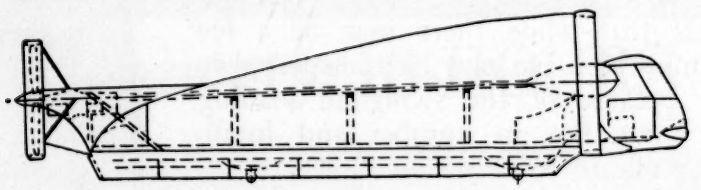
The pre-loaded pallets can be selected from the loading dock and placed aboard the aircraft in any sequence needed to ensure an optimum weight and balance. Both Flying Tiger and Seaboard agree that the CL-44 is not overly sensitive to center of gravity location and has a relatively wide range throughout which a load can be distributed without adversely affecting safety or performance.

Cargo which cannot be accommodated on the pallets will have to be loaded by conventional methods using hoists and fork lifts. This will slow the unit loading method, but, as in the past, probably will account for only about 5% of the freight carried.

Flying Tiger's loading system will require minor changes in the terminals in Boston, New York, Philadelphia, Cleveland, Detroit, San Diego, Los Angeles, San Francisco, Portland and Seattle. A new terminal will be built at Chicago, where none now is located. Cost of construction needed to accommodate the CL-44D at all other facilities amounts to only $2,500.







dependable transportation...come hi

or high water

In 1959 the Army asked Aeronutronic Division of Ford Motor Company to investigate the practicality of air cushion vehicles.

Today Aeronutronic has advanced designs for two such carriers. Both will be able to travel almost anywhere, skimming five feet above the surface, unhampered by the weather or the extremes of climate.

Although planned for different payloads and missions, both are highly maneuverable, simple to operate and easily and quickly serviced. They are intended to be specific answers to the problems posed by the limitations of conventional transportation.

The smaller of the two Aeronutronic-designed vehicles will weigh 8,000 pounds, carry a 2½ ton payload, cruise at 40 mph. It will have a range of 100 miles and a grade capability of 30%.

The big machine is a high-speed, heavy duty carrier. Weight: a hefty 44,500 pounds, payload: 22,000 pounds, speed: a fast 80 mph, range: 300 miles. It, too, will have a grade capability of 30%.

In spite of this evidence of accomplishment, Aeronutronic's work in the field has just begun. Army Transportation Corps and Navy contracts are speeding further studies into the potentialities of the new vehicle. The ACV is destined to play a significant role in future military and civilian transportation.

Further information regarding the air cushion vehicle, as well as other exciting projects in work at Newport Beach, may be had by writing to Aeronutronic.

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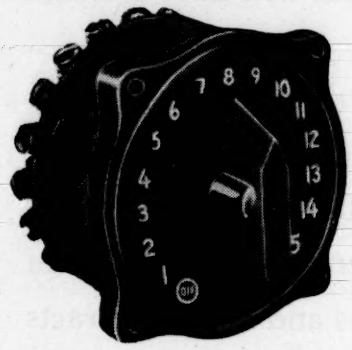

Flanged Cases in 2 inch 3 inch 4 inch dia.

Engineered to give years of service in test work as well as in permanent installations, LEWIS switches have heavy, low-resistance contacts; positive detent action and sturdy terminals for easy wiring.

The cases are splash proof and dust tight, of close fitting bakelite. Husky black-finished aluminum indexing knobs are used to turn the stainless steel shaft supporting the rotating brushes.

RESISTANCE BULB SWITCHES

A companion line of the same construction except that they are fitted with a common-terminal ring for three-wire bulb connections.

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Write for our descriptive bulletin on Selector Switches

The LEWIS ENGINEERING CO.
Specialists In Temperature Measurement
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PRODUCTION BRIEFING

Vernier engines for mid-course velocity correction and attitude stabilization of the Surveyor lunar probe will be provided by Reaction Motors Division, Thiokol Chemical Corp., under an approximately $2-million subcontract from Hughes Aircraft Co., system prime contractor. The system will employ three engines, positioned 120 deg. apart around the Surveyor's main retrorocket.

Aviation industry representatives have been invited to the General Electric Large Jet Engine Department at Cincinnati Nov. 9-16 to discuss installation configurations and component development of the MF295 engine, which was designed for the TFX tactical fighter weapon system.

Robert G. Nunn, Jr., formerly special assistant for communications satellites in the National Aeronautics and Space Administration, has left the agency and joined a Washington law firm. Nunn's job dealt with policy and interagency liaison, and will now be handled directly by James E. Webb, NASA administrator.

Marshall Space Flight Center has requested quotations from 54 contractors for support services at the Michoud, La., facility. The contract for housekeeping will go to a single firm, and the center has opened the bidding to all potential contractors.

Lockheed Missiles and Space Div. has been awarded a $65,000 interplanetary transportation study contract by NASA's Marshall Space Flight Center, Huntsville, Ala. Interplanetary spacecraft orbits, times, speeds, directions and dates for the launches will be studied.

Bids are being invited for design, fabrication and testing of two hot gas generator type water injection steam generator units for the test cell "D" complex of the nuclear rocket experiment area of the Atomic Energy Commission Nevada test site. Value of the contract is estimated at more than $100,000 and bids will be opened Dec. 5. The test cell "D" complex will be part of the big National Nuclear Rocket Development Center.

Sud Aviation has received 59 firm orders for the Alouette III turbine-powered helicopter, of which only 12 are from the French government. An initial production order of 100 is planned. The seven-passenger helicopter is powered by a 550-hp. Turbomeca Artouste 111B engine.

Royal Air Force has ordered an undisclosed number of Honeywell systems analyzers for the English Electric Lightning fighter. Order was placed with Honeywell Controls, Ltd., subsidiary of Minneapolis-Honeywell. Analyzer has been in use on the F-101 maintenance program, and has been ordered for F-104s built in Canada and West Germany and for the Japanese air force.

Aerolab Development Co., of Pasadena, Calif., a subsidiary of Marshall Industries, will provide Argo D-4 rocket systems, engineering and field services to the Air Force in a program to obtain scientific information about the earth's magnetic field in the region of the inner Van Allen belt.

Air Products and Chemicals, Inc., Allentown, Pa., will construct a liquid hydrogen servicing system for fueling upper stages of follow-on Saturn space vehicles at Cape Canaveral, Fla. The $1.7-million contract from National Aeronautics and Space Administration's Marshall Space Flight Center calls for the facility to be located at Saturn Complex 37 about one mile north of the present Saturn Complex 34 and to be completed in late 1962.

Underwater, torpedo-like oceanographic research vehicle is being built by the Aeronautics Division of Ling-Temco-Vought for the Office of Naval Research and Navy Hydrographic Office. The 12-ft.-long, 21-in.-dia. vehicle is designed to operate independently of the mother ship and to have long-range capability. The oceanographic research vehicle will be used in the evaluation of sonar equipment.

Collins Radio Co. of Cedar Rapids, Iowa, will provide Horizontal Situation Indicator equipment for F4H aircraft under a $765,000 contract from McDonnell Aircraft Corp.

Hydro-Aire Division of the Crane Co., Burbank, Calif., has received a $674,421 contract from the Boeing Co. to provide fuel boost pumps for Boeing B-52H ballistic missile bombers.

Republic Aviation Corp., Farmingdale, N. Y., has established a chemical milling facility at its main plant to produce high strength lightweight aluminum parts for Republic's F-105D fighter-bomber. The company reported that the new facility will enable Republic to handle over $1 million production work that would otherwise have to be subcontracted.

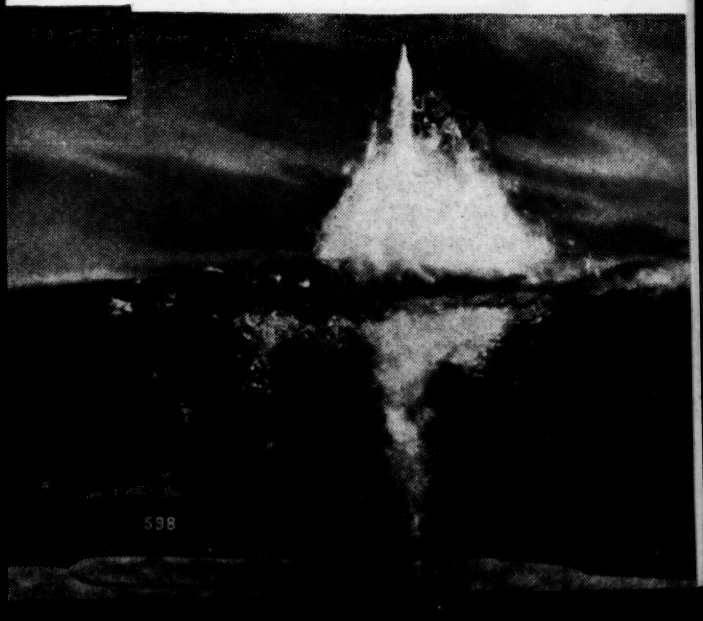
Avco and Polaris

Now at sea—or soon to be—are the nuclear submarines *George Washington, Patrick Henry, Ethan Allen* and *Robert E. Lee.*

Carried aboard such submarines are sixteen Polaris missiles. Their critical arming and fuzing system was manufactured by Avco's Electronics and Ordnance Division.

100% successful in all flight tests to date, the tactical units were ready for delivery only twenty-two months after the start of development. This is the record of the U. S. Navy's Special Projects Office, the U. S. Naval Ordnance Laboratory, and Avco's Electronics and Ordnance Division on the Polaris arming and fuzing system.

Detonation at the right time and place is the kind of engineering and production problem that Avco's Electronics and Ordnance Division is well qualified to solve. If you would like more information about Avco's experience and capabilities in this, and other related fields in ordnance, write: Director of Marketing, Ordnance Operation, Electronics and Ordnance Division, Avco Corporation, Richmond, Indiana.



Opportunities for electronic engineers (EEs) in communications, infrared, radar, optics, reliability. Send résumés **to:** Dept. FP, Industrial Relations, Avco Corporation, Electronics and Ordnance Division, Cincinnati 41, Ohio.

Avco ELECTRONICS AND ORDNANCE DIVISION

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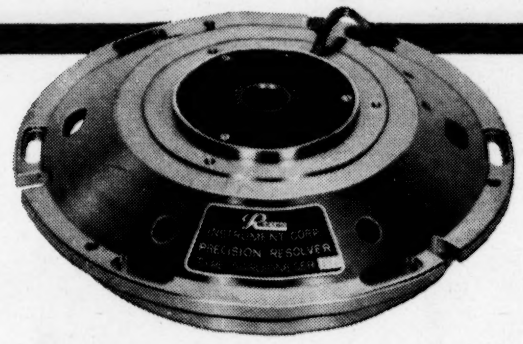
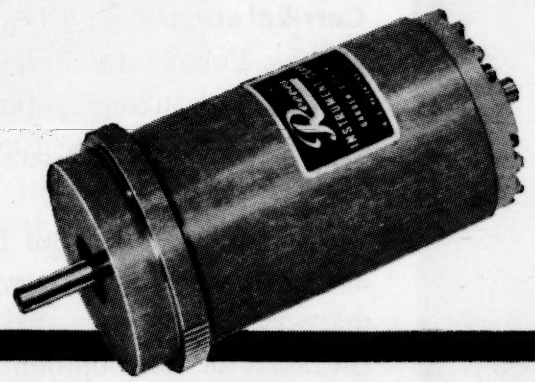


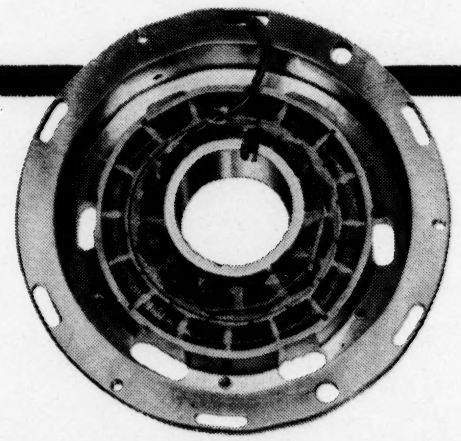
10-SECOND ACCURACY PANCAKE RESOLVER

Integral bearings permit direct mounting to gimbal structures of stable platforms. Beryllium housings provide highly stable operation in environments with extreme temperature variations.



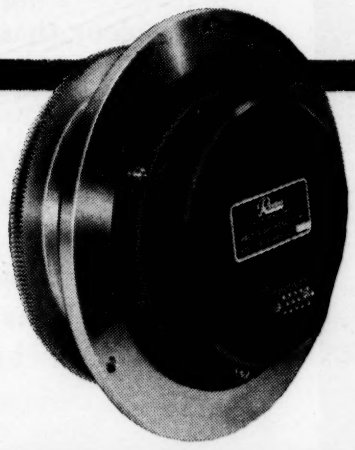
20-SECOND ACCURACY SIZE 23 RESOLVERS

Double-ended design simplifies their incorporation into data transmission systems.



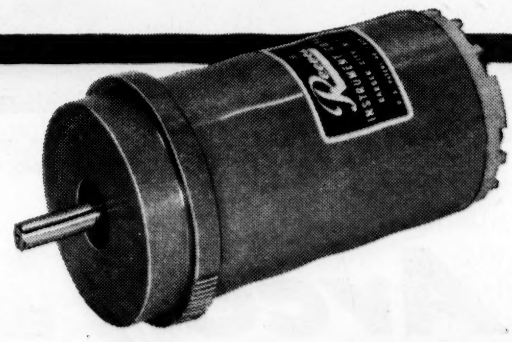
HIGH IMPEDANCE PANCAKE RESOLVERS

Tuned impedance of 80,000 ohms makes these units ideally suited for use as control receivers. Rotor and stator assemblies may be independently attached to their mounting members. Standard units have an accuracy of **3 minutes of arc.** One-minute accuracy can be supplied on special order.



0.005% FUNCTIONAL ACCURACY PANCAKE RESOLVER

100% compensated Resolver with integral Class III precision rotor gear. The ideal unit for high accuracy computer chains.



0.01% FUNCTIONAL ACCURACY SIZE 23 RESOLVER

100% compensated winding. Extreme accuracy in a standard resolver case size.

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Reeves

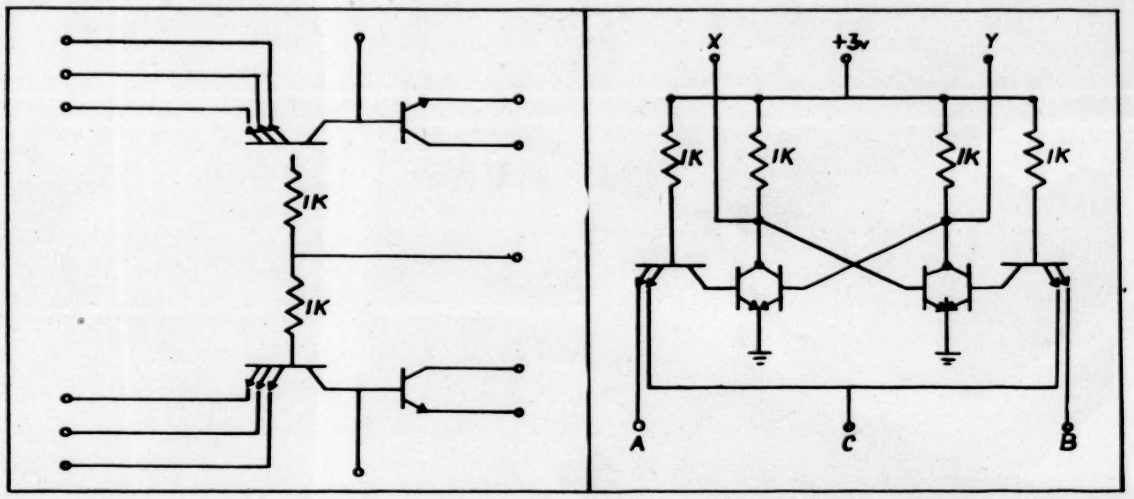
New Integrated Circuits to Be Marketed

By Barry Miller

Culver City, Calif. – Integrated avionic circuits designed to combine the high performance and flexibility of individual quality transistors with the potentially low cost and high reliability features of integrated circuitry will be made available at the end of the year by Pacific Semiconductors, Inc.

New circuits are in the general class of devices known as integrated circuits, or functional blocks, in which a complete circuit containing identifiable components is fabricated by known techniques of semiconductor diffusion in a common semiconductor substrate. Devices of this type are being marketed by several companies, including Texas Instruments, Inc. (AW Nov. 6, p. 83) and also Fairchild Semiconductor Corp.

Each element of every transistor in the single circuit as made by Pacific Semiconductors is electrically isolated to give the system designer freedom in connecting the devices as he wishes.



TYPICAL INTEGRATED avionic circuits employing TCTL (Transistor Coupled Transistor Logic) include gate circuit (left) and flip-flop (right). The former conveniently fits 50 mil square structure; the latter 65 mil square. Circuits are suitable for three volt operation.

Customer Needs

Throughout its integrated circuitry development efforts, Pacific Semiconductors chose to stress processes rather than a particular circuit organization or packaging approach so that it could satisfy different customer requirements. Nevertheless, like others working in this field, it soon settled on a favored circuit organization which it, and several manufacturers who have sampled the devices, believe has distinct advantages.

This organization approach involves use of multiple emitter transistors, rather than diodes for coupling. The organization technique is called TCTL (transistor coupled transistor logic) compared with conventional DCTL (direct coupled transistor logic). TCTL, the firm says, will enhance the electrical performance of integrated circuits.

By Jan. 1, a 20-nanosecond integrated circuit flip-flop using TCTL will be offered by Pacific Semiconductors at an initial price of slightly less than $100.

This price will make the device competitive with the Fairchild integrated circuit flip-flop (which sells for $120 apiece in small quantities today, and is expected to drop in price by the year's end) and similar devices made by Texas Instruments.

Pacific Semiconductors' flip-flop is composed of two double emitter transistors, two common emitter transistors and four resistors. In designing the flip-flop, the emphasis was placed on maximizing transistor elements and minimizing passive components as the cost of the former, when made in batch process, adds little to the cost of the circuit.

This circuit can be contained on a 65 mil square wafer but initially will be offered by the firm on multiple lead TO5 headers.

Developmental samples of what the company calls a universal gate circuit with a sufficient number of leads to be used as various types of gates will be available on multiple lead TO18 headers at about the same time. As shown in an accompanying drawing, with any one of the emitter leads at a low potential, the collector of the first transistor will be low ("and" gate). The circuit becomes a "not and" gate with the second transistor inverter.

Microminiature Packages

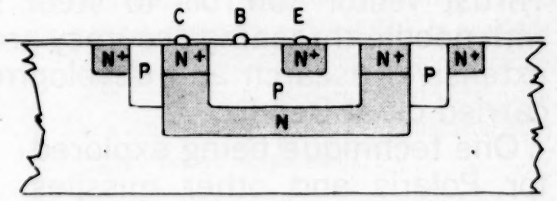
Eventually, the company expects to make these devices in one of the two new industry accepted microminiature packages, the TO51. The TO51 conforms with the package dimensions recommended last year by a group of users within the Electronic Industries Association (AW Sept. 5, 1960, p. 90). This package is 60 mils max. thickness, 165 mils max. diameter and has flat ribbon leads. Both the flip-flop and the universal gate should fit into packages of this size although headers with the necessary number of leads (7 and 12, respectively) may be needed. As many as 144 integrated circuits, in matrices of 12 x 12, can be fabricated on a single 5 mil slice of silicon cut from a $\frac{7}{8}$ in. dia. silicon crystal.

Advantages of TCTL, cited by Pacific Semiconductors, are that it prevents current hogging, provides a means of fast coupling, allows logic switching to be conducted in the coupling and like DCTL provides a tolerance against false currents.

DCTL Devices

Although the company favors the TCTL approach, it will make devices utilizing the DCTL logic at specific request.

In the technique employed by Pacific Semiconductors, semiconductor components and resistors are made by a series of three diffusions. Starting with lightly doped P material substrate, three successive semiconductor diffusions are performed with the aid of photographic masks. Initially, an N-type (phosphorous) material is diffused into the substrate to form the collector. This is followed by P-type (boron) diffusion of the base. In the same step a P material guard ring is formed around the collector and base structure as isolation for them. The final diffusion simultaneously forms a high-conductivity type N material as emitter and also above



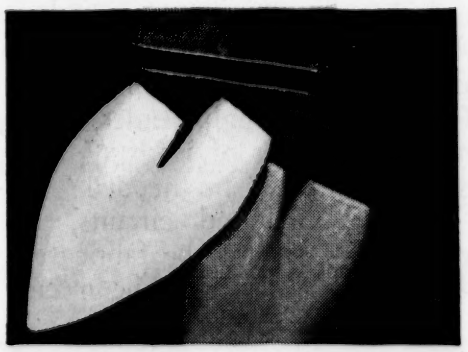
CROSS SECTION of silicon slice indicates how isolation of collector, base and emitter elements is achieved in structure employed by Pacific Semiconductors' integrated circuit approach. Silicon dioxide coating passivates semiconductor surface and isolates junctions. The structure is approximately 5 mils in depth.

Accurate enough to help put a missile through a needle's eye . . .

BENDIX NOZZLES FOR THRUST VECTOR CONTROL

Thrust vector controls to steer space vehicles with needle-threading accuracy are the subject of extensive research and development now being carried on at Bendix.

One technique being explored for Polaris and other missiles and spacecraft is secondary injection. The use of liquid or gas to deflect the exhaust jet provides a control system of great simplicity and reliability, while maintaining pinpoint accuracy. Another Bendix control development—part of the Minuteman program—is movable nozzles. A pressure-tight, flexible seal permits nozzle swiveling to provide thrust vector changes, allowing course and/or attitude corrections. Qualified contractors: write us at South Bend, Indiana, for more details.



Bendix Products Aerospace Division

THE Bendix CORPORATION

the collector (serving to reduce emitter and collector saturation resistance). Resistors are formed simultaneously with the boron diffusion of the base.

Two micron aluminum spots are deposited on the three transistor elements as contacts, silicon dioxide film is deposited to passify the semiconductor surface and isolate junctions. Interconnections are achieved by evaporating aluminum conductors among the terminals.

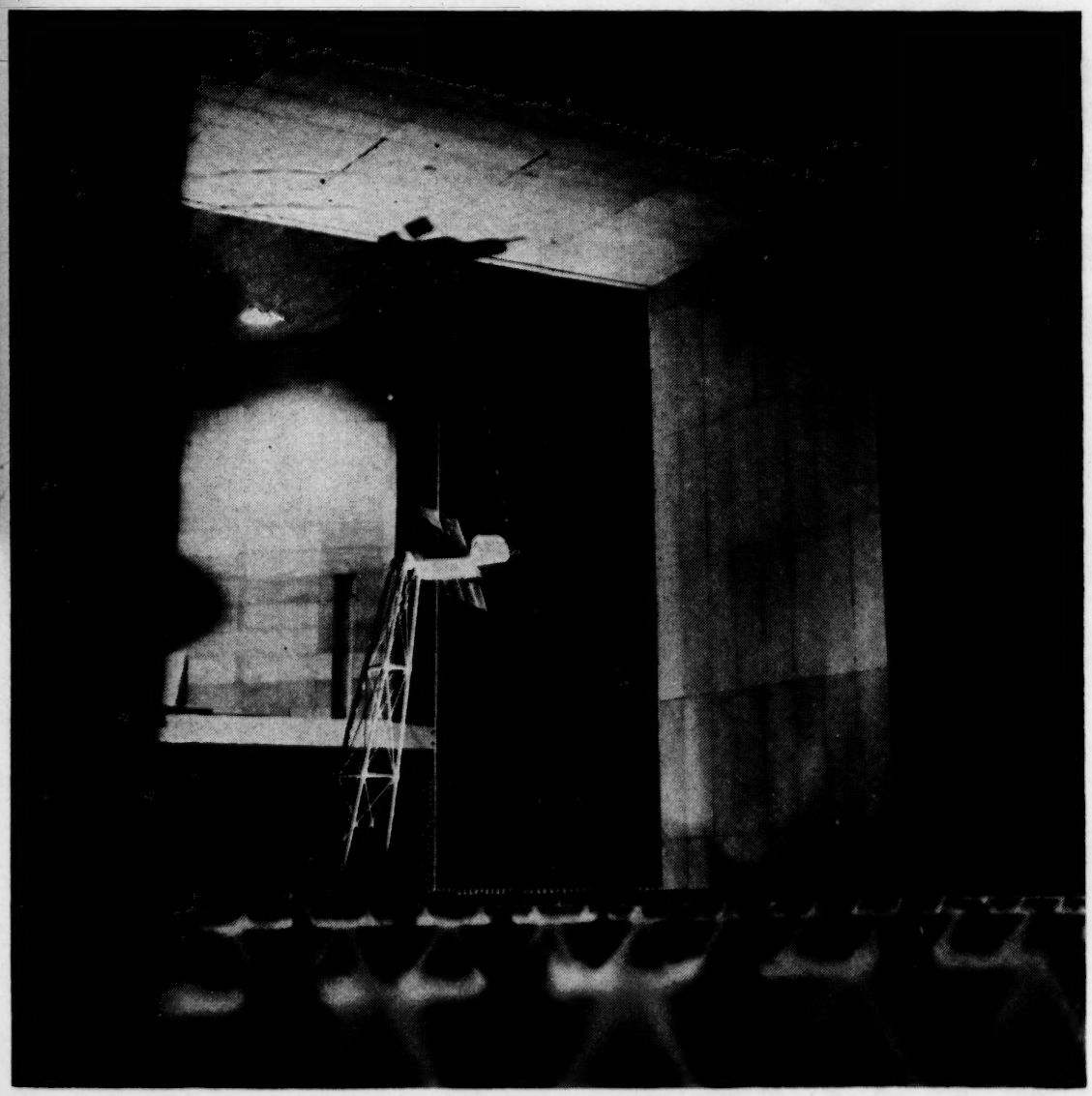
Both evaporation of thin film resistors and diffusion of semiconductor resistors were examined by the company with the latter selected for integrated circuit because of their smaller size and higher power dissipation. Power dissipation for diffused resistors is 2 kw. per square cm. compared with 10 watts per square cm. for films. Tolerances that can be achieved with diffused resistors are not close (± 25%) but are satisfactory for saturated switching circuits, according to the company.

Resistors are formed in 150 ohms/sq. quantity and a typical 1,000 ohm resistor (± 25%) measures ¾ mil wide, 4½ mils in length. For more precise resistance values trimming tabs could be employed and tailored to need. For diffused resistors in values from 10 ohms to 5,000 ohms, the temperature coefficient in the zero to −100C range is −0.3% per deg. Centigrade and from zero to 200C it is +0.2% per deg. Centigrade. In resistors of this type there is distributed capacitance of about three picofarads.

Transistor made by this process and employed in a saturated switching circuit provides typical propagation time of less than 10 nanoseconds, storage time with turnoff base current of zero is less than 5 nanoseconds. Saturated collector to emitter voltage is 0.175 ±0.025 from −55 to 175C. Saturated base to emitter voltage is 0.7 v. ±0.2 v.

Breadboard Circuit

In preparing integrated circuits, a breadboard circuit is made up and a topological layout which minimizes crossover is prepared. Five 400 times final size scale drawings, representing the five process steps, are prepared element by element. The elements are pasted up, and photo-reduced 20 times in size. Each pattern is visually aligned, step and repeat printed into a matrix of partial circuits (element by element), typically 12 x 12. Then the matrix pattern is reduced by a factor of 20 to its final size onto a glass plate.

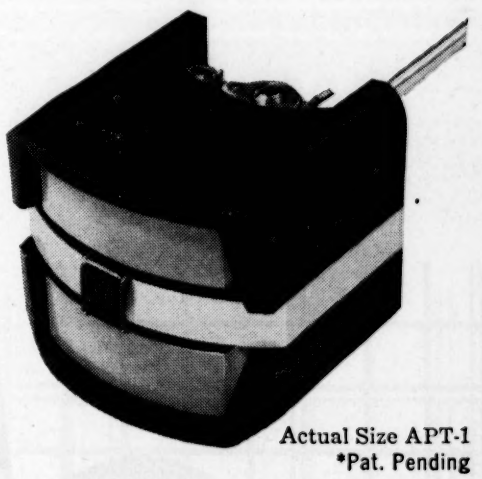


Chamber Tests OAO Radiation Pattern

Largest radio frequency anechoic chamber in the U.S., in Grumman's $5-million electronic systems center, is being used to test antenna radiation pattern for Orbiting Astronomical Observatory (OAO) satellite (AW May 22, p. 83). Chamber measures 110 ft. long, 40 ft. wide and 25 ft. high.

APT

ASTATIC PANCAKE TORQUE-TUBE*



Actual Size APT-1
*Pat. Pending

BETTER BASIC MECHANISMS

The APT-1 is an entirely new concept in a permanent magnet moving coil mechanism designed specifically to exceed the performance of the best available comparable devices. Typical improvement factors in major performance categories include:

Torque . . *increased* 275%

Weight . . *reduced* 30% (in moving coil system)

Torque-to-Weight . . *increased* 400%

Compass Influence . . *not measurable* under standard test conditions

Vibration . . *substantial elimination* of resonant phenomena and greatly improved endurance are assured by dynamic symmetry of moving coil system and 400% increase in T/W ratio

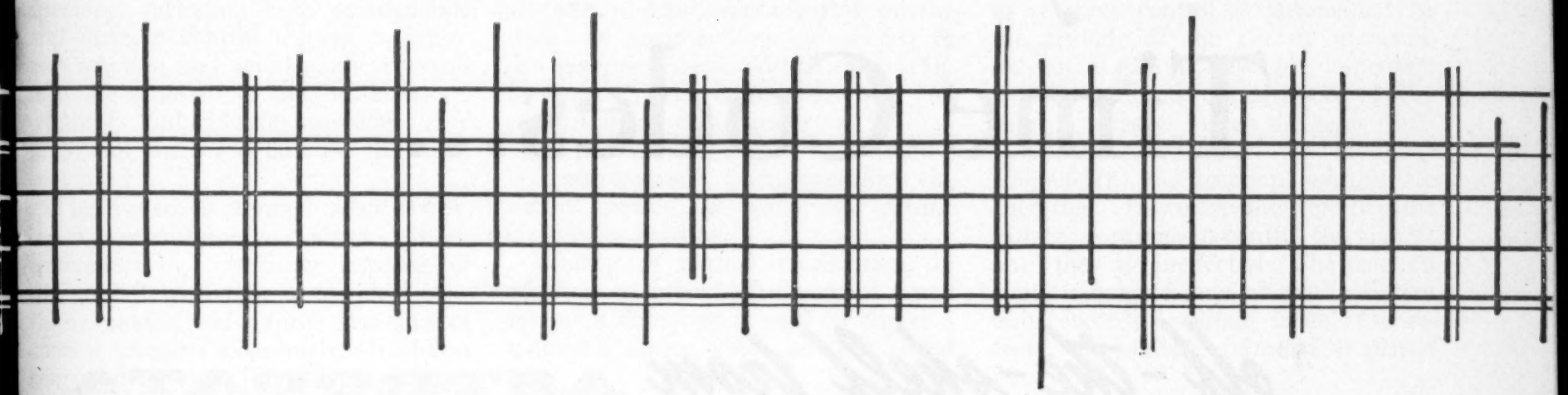
Acceleration . . . *indicator errors* produced by acceleration forces are very sharply attenuated

Linearity . . *improved accuracy and linearity* are an assured consequence of the fundamental design, which has over 75% of the copper winding working in a high energy air-gap composed of coplanar surfaces, providing greater averaging of a more uniform magnetic field

APT-1 characteristics offer distinctly improved performance in all airborne indicating systems and control applications. The APT-1 is available in a wide range of electrical and dynamic characteristics with conventional jewel and pivot suspension, and in a limited range of electrical characteristics with Elgiloy flexure suspensions.

For information on the application of these mechanisms, write **Ammon Instruments, Inc., 345 Kelley Street, Manchester, N. H.**

AMMON
INSTRUMENTS, INC.



genus: homo · species: sapiens discipline: factors engineering

At the six major RCA Defense Electronic Products facilities, teams of psychologists and design engineers are deeply involved in the highly specialized, incredibly complex study of human factors engineering—man/machine interfaces, auto-instructional methods, decision processes, read-in/read-out optimization techniques, sensory perception, the entire spectrum of psychological-physiological-physical disciplines.

Whether your requirements involve human factors study of command and control functions for defense networks, or projected life support systems for space exploration, a total RCA capability stands ready to assist you . . . from feasibility study to project completion. Write Defense Electronic Products, Radio Corporation of America, Camden, N. J.

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Astrodata's complete line of solid state time code equipment is built to MIL requirements around modular plug-in circuit cards. Right now cards are on the shelf for all time code formats in use today, including IRIG Members A, B, C, and D; NASA 36-, 28- and 20-bit; Atlantic and Pacific Missile Ranges, Eglin, White Sands, etc.

Using these standard modules, and combinations thereof, Astrodata supplies "custom" generators/translators in the shortest possible time and for the lowest possible price. No costly engineering design is involved.

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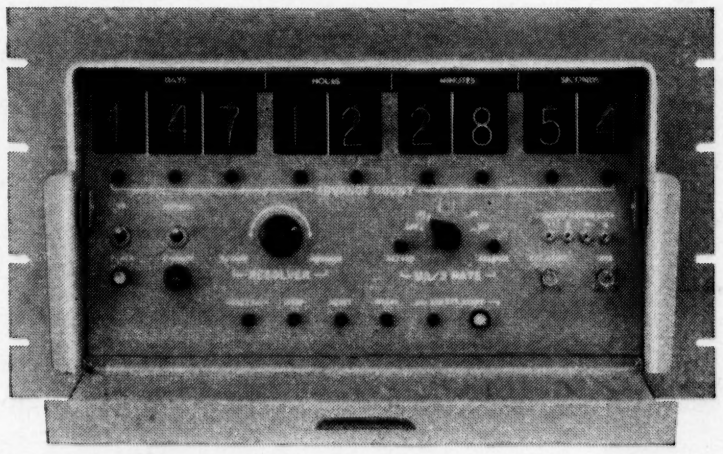
We invite you to investigate, and will be happy to supply names of customers in your area.

Example of Astrodata Time Code Equipment



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X-15 Will Test Adaptive Control System

By George Watson

Minneapolis—Adaptive flight control system developed by Minneapolis-Honeywell Aeronautical Division is expected to be flight-tested in the number three North American Aviation X-15 research aircraft within the next few weeks.

The system is designed to provide stability augmentation and automatic guidance throughout the X-15 flight envelope, including both aerodynamic and reaction control regions, incorporates reaction and aerodynamic controls into the same stick, and has elaborate reliability and fail-safe provisions. (See p. 52 for further details on the X-15 program.)

The system is termed adaptive because it continuously evaluates its effectiveness by comparing response of the aircraft with that of an ideal electronic model, and adjusts the gain of control circuits accordingly. It differs from conventional (non-adaptive) flight control systems in that it maintains control in a changing environment without relying on prescheduled gain adjustments derived from direct measurements, such as air density and speed. The adaptive feature makes possible flight control over the entire X-15 envelope with a single system which does not require programing of conditions to be encountered or aircraft performance, according to Minneapolis-Honeywell. This is an important advantage because of the difficulty of predicting environment and performance at extremely high altitudes and speeds.

Damping Provided

When operated in the stability augmentation mode, the system provides pitch, roll and yaw damping. Pilot commands are fed to the ideal electronic model as a signal proportional to stick or rudder pedal force. In the pitch control portion of the system, an accelerometer and rate gyro feed normal acceleration and pitch rate data to the system, which compares these with the "ideal" performance of the model, and adjusts trim to provide adequate pitch damping. Roll and yaw damping are accomplished in a similar manner. Roll damping is obtained from roll rate signals; yaw damping, from lateral acceleration and yaw rate signals.

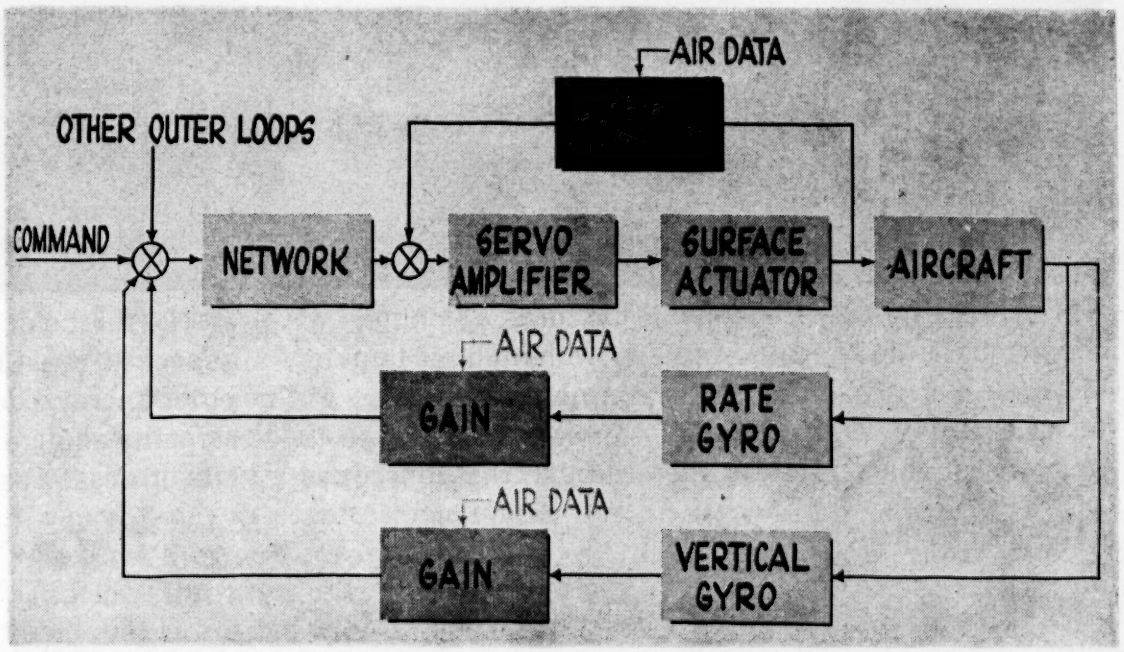
When operated in the automatic guidance mode, the system provides angle-of-attack hold and attitude hold in the pitch axis, attitude hold and heading hold in the roll axis and heading hold in the yaw axis. In the reaction region of flight, heading cannot be changed by banking the aircraft because little or no aerodynamic force is present. Therefore, heading control is automatically transferred from roll to yaw when the aircraft passes from aerodynamic to reaction flight. The angle-of-attack reference signal is obtained from the flow direction sensor; the pitch and roll attitude hold and heading hold signals are obtained from the stable platform. The pilot can make changes in heading (in the aerodynamic region), angle of attack, and pitch and roll attitude by depressing a button on the stick and commanding the aircraft to the new orientation. When the button is released, the automatic hold reengages at the new orientation.

In the reaction region, the heading hold automatically disengages when the rudder pedals are used, to permit changes in heading.

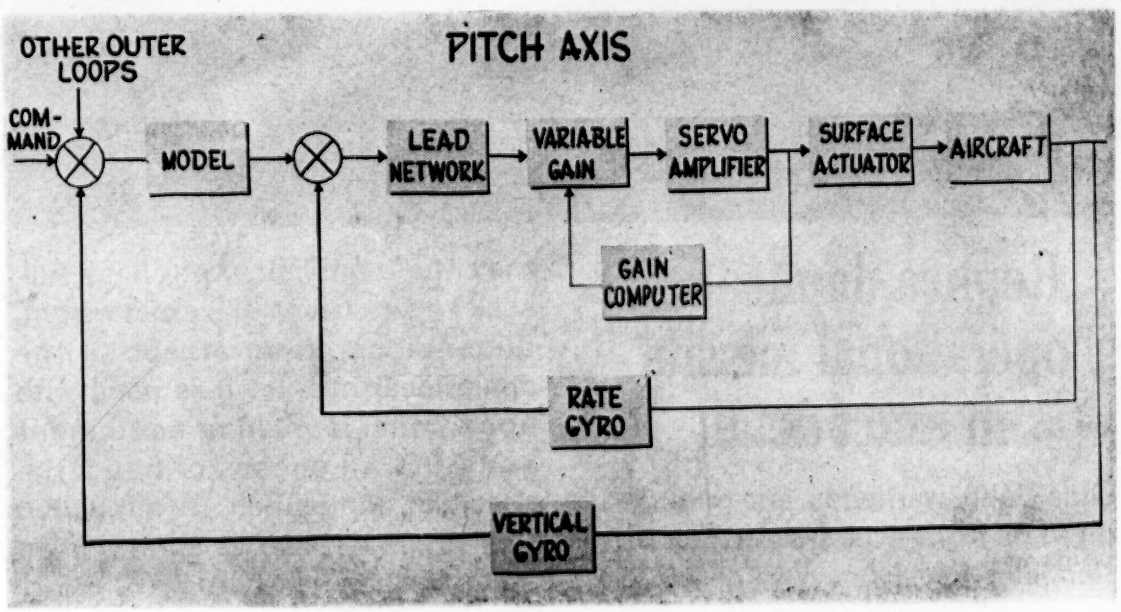
Sensing of normal acceleration, in addition to providing a control signal for pitch damping, is used to trigger a g-limiting device which provides added safety during atmosphere re-entry. If normal acceleration increases above 6g, a feedback signal is introduced so that a pilot command for a higher g level requires considerably greater stick force. If the 6g limit is exceeded with the pitch attitude or angle of attack hold engaged, the reference angle is automatically reduced.

Control Transition

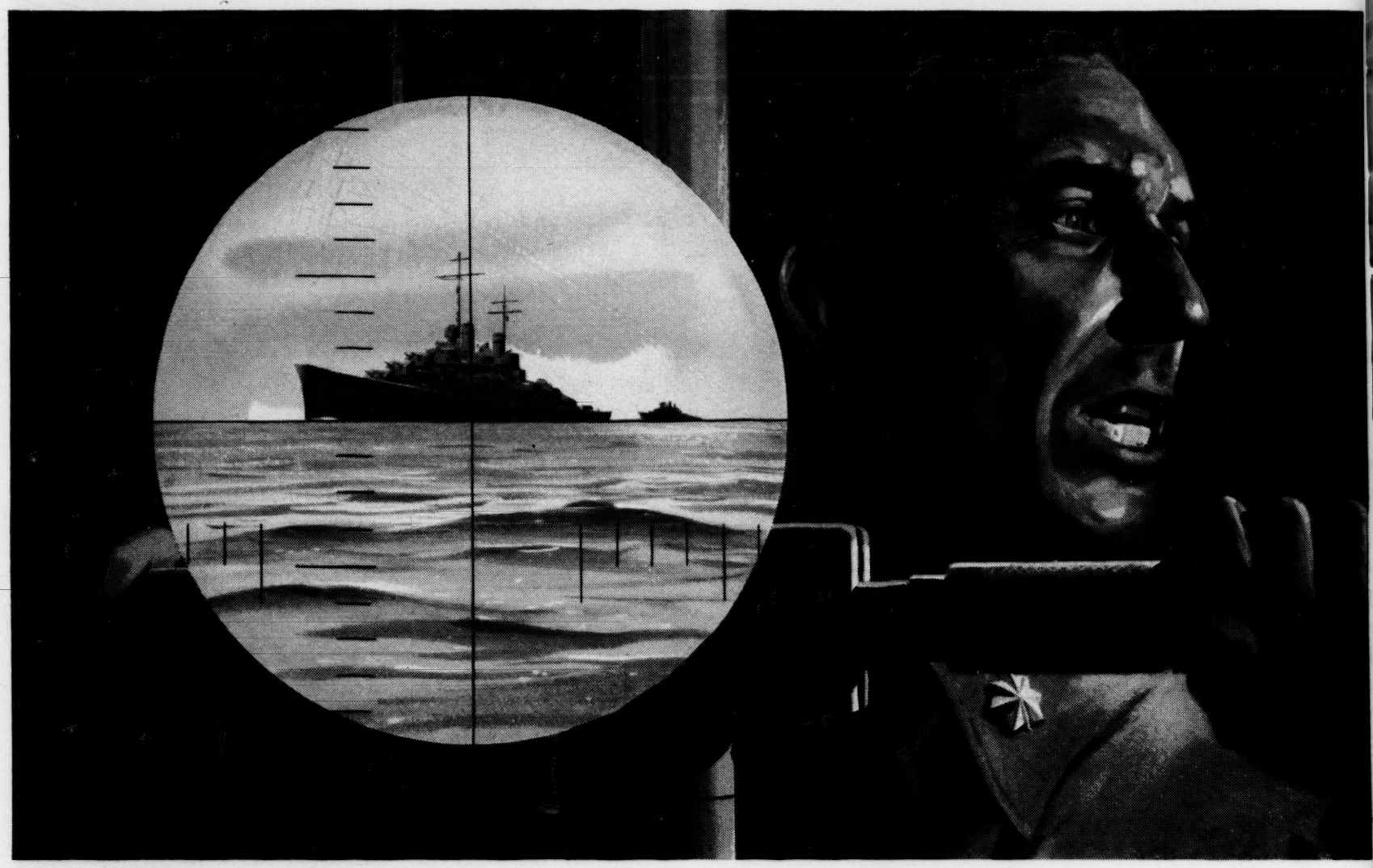
Transition from aerodynamic control to reaction control is automatic. As the altitude of the aircraft increases, the system gain increases to compensate for the reduced effectiveness of the control surfaces. When the gains reach about 80% of maximum value (at about 130,000 ft.) the reaction controls are energized. However, the aerodynamic surfaces continue to control the aircraft until they are ineffective. The reaction controls operate only when the system error exceeds a certain value. On reentry, the burden of control is placed



DIFFERENCE BETWEEN ADAPTIVE and conventional flight control systems is illustrated in these block diagrams. Conventional system, top, requires continuous input of air data. Adaptive system, bottom, does not use air data, but compares actual aircraft performance with that of an "ideal" electronic model.



NEW SIMULATORS



ATTACK SUBMARINE TRAINER captures a "chunk" of ocean miles wide and fathoms deep, with multiple targets, including aircraft—indoors. Environmentally realistic Attack Centers of three classes of atomic subs are used to train crews. The seascapes seen through the periscopes are in full color and targets change bearing, size and aspect as real-time battles progress in this digital-computer oriented device. The computer program generates as many as nine different weapons and also determines hits or misses as if in actual combat.*

Replica duplicates operational missile in exact detail

Little John warheads are manufactured by Honeywell's Ordnance Division. Likewise, Honeywell developed the Little John Trainer which is a full-scale replica having the exact weight, dimensions, and balance of the operational missile. It is used with operational launching equipment and GSE. All phases of handling, checkout and launch are simulated realistically—even to smoke from motor ignition and burning.*

Shipboard device cuts cost of training crews

Mk 6 Launcher and Missile Simulator exactly simulates launcher and missile functional inputs, without utilizing operational equipment. Bypassing of the operational launcher reduces wear and maintenance, keeping it constantly available for tactical use and permits shipboard weapon system training without the expense of firing live missiles. The simulator also provides capability for malfunction insertion for trouble-shooting exercises. The Mk 6 was developed under the direction of the Bureau of Naval Weapons.

LOWER RISK, COST OF "COLD WAR" TRAINING

Honeywell specializes in all areas of this challenging technology

Economy—of money and amount of operational equipment required—is the key to the success of simulation specialists. If men can be trained without firing an operational missile, or, if a simplified version can substitute for a complex, expensive device—money is saved. Likewise, an economy is realized if a trainer-simulator replaces operational equipment, freeing it for strategic deployment. This is especially true in team training where large amounts of equipment might otherwise be tied up. Simulation is at its best in the training of complete teams.

Simulation is planned, technological wizardry—wizardry that is exactingly realistic. The success of simulation lies in analyzing operational equipment and substituting simulated inputs for the operational equipment. The net result is appreciable savings in "hardware" and money, while retaining a realistic training environment.

Simulation involves optics, sound, dynamics of motion, electronics, mechanics, and discrete application of human factors engineering. Honeywell has a wealth of experience in these fields, including space, aeronautical, terrestrial and marine simulation. The examples shown here are proof of this capability.

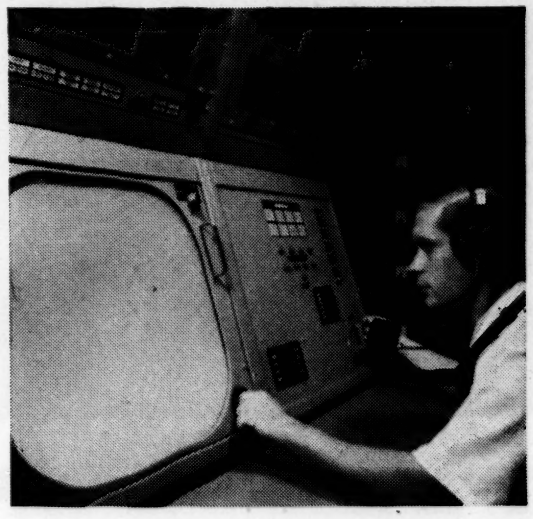
If you would like to know more about Honeywell capabilities in designing and producing trainers, contact your local representative, or write: Honeywell Ordnance Division, Duarte, California. Sales and service offices in all principal cities of the world.

Missile launcher provides realistic "in action" feel

Redeye, an infrared homing missile fired from a lightweight, bazooka-type launcher, arms the ground soldier against low-flying aircraft. Honeywell's Redeye trainer, which is currently under development, will simulate the effect of blasting and tracking. The simulator will provide both basic weapon training and continuing field proficiency, without expenditure of a live missile.*

ASROC Trainer serves fleet

The ASROC Trainer is a shore-based installation of six shipboard compartments containing a total simulation of sonar, radar, fire control including a special purpose computer, and associated equipment. This ASW team-trainer prepares fleet personnel for the tactical deployment of the ASROC Weapon System.*



*Developed (or under development) under the direction of the Naval Training Device Center, Port Washington, New York.

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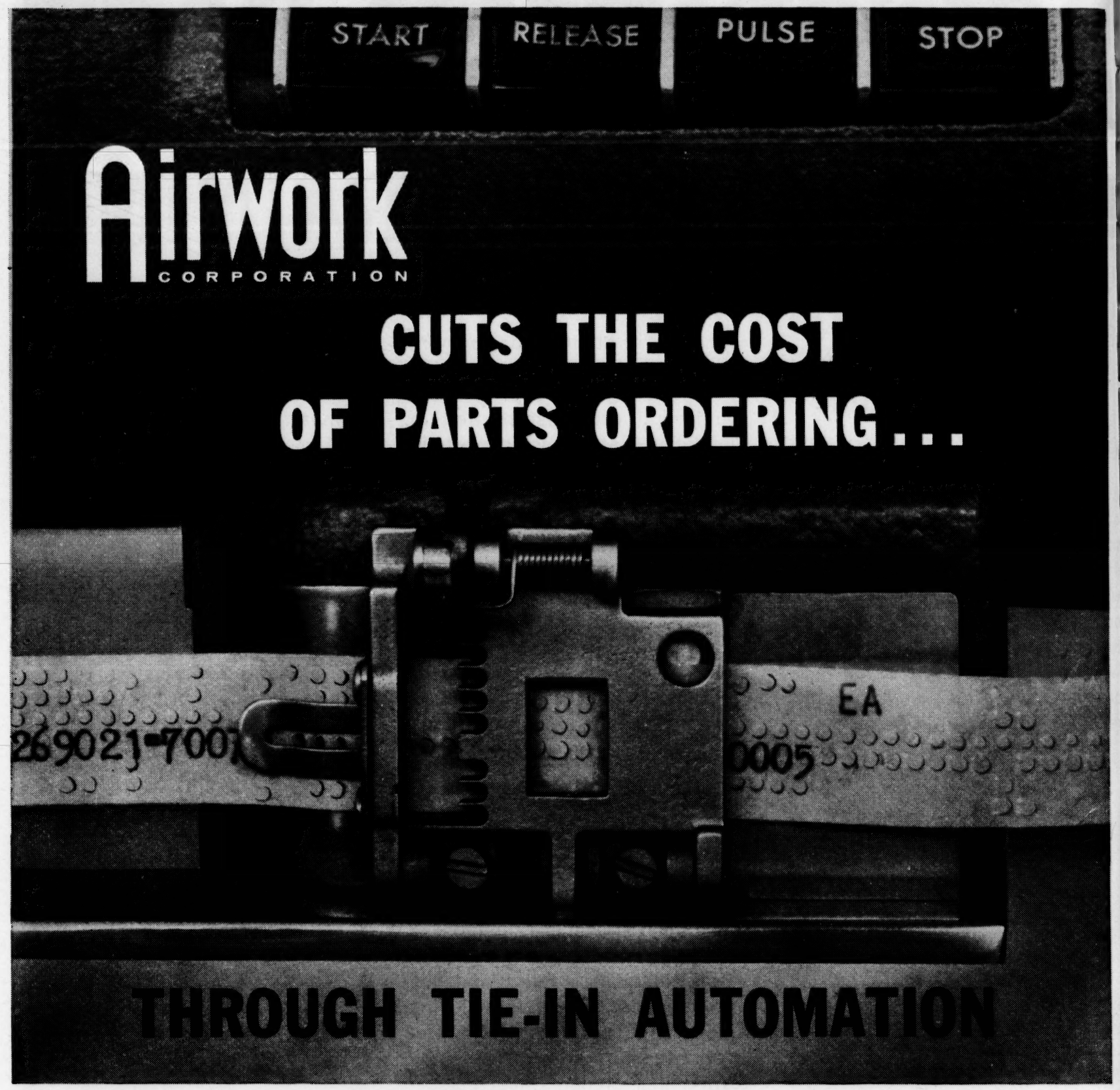

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on the aerodynamic surfaces as soon as possible. When the system gains have decreased to 60% of their maximum value, the reaction controls are de-energized. This procedure is intended to conserve reaction control fuel by making maximum use of aerodynamic control.

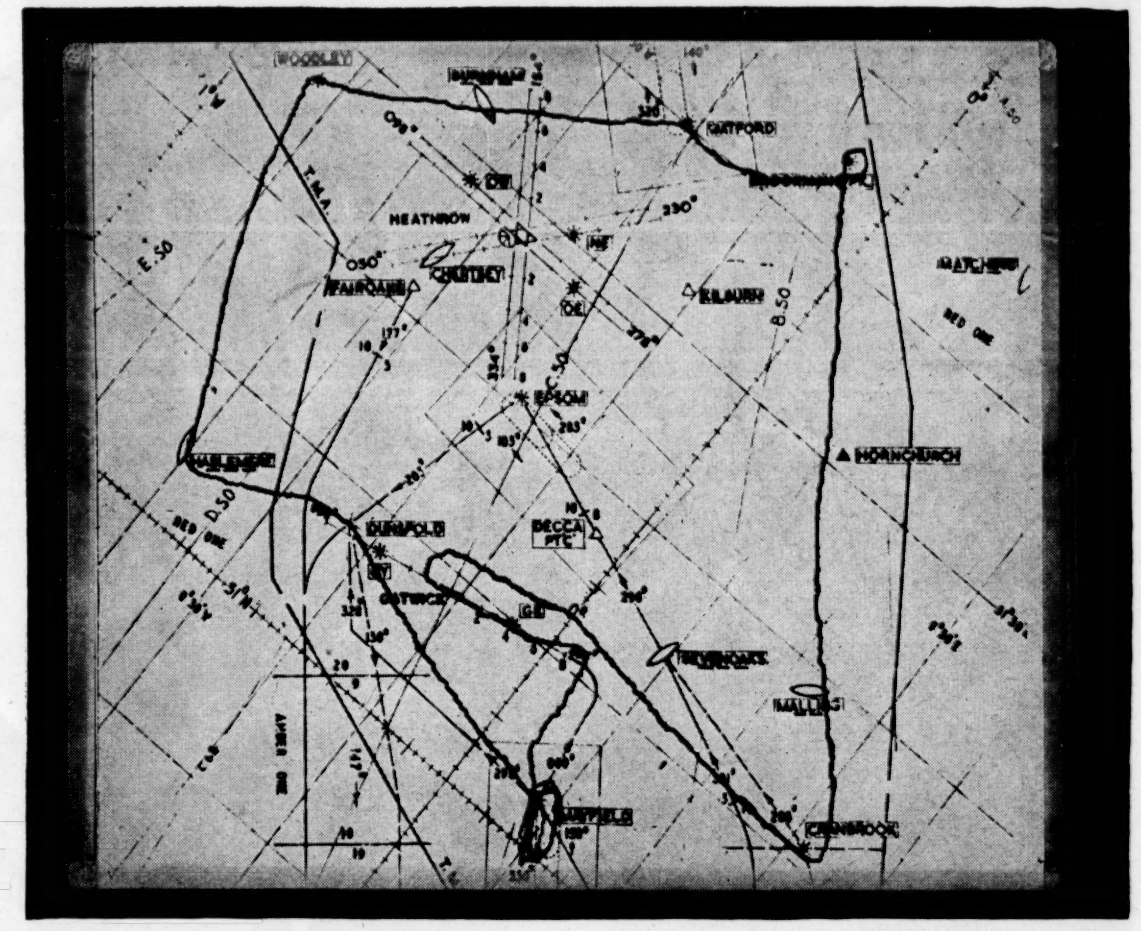
Through the use of dual redundancy, Minneapolis-Honeywell hopes to achieve a mean time between failures of 200,000 hr. for sensor and electronic portions of the system. For an equivalent non-redundant system, mean time between failures has been estimated at 300 hr.

Each control axis of the system has dual parallel channels, and incorporates dual rate gyros and servo pickoffs. Two lateral and normal accelerometers are used. Dual rudder pedal and stick pickoffs, which transmit pilot commands to the control system, are provided. Less critical inputs (roll and pitch attitude, angle of attack and heading) are not dual, but the single input is fed into both channels of the appropriate control axis.

Because each control axis has two parallel adaptive channels, open-circuit (no-signal) failure of a single channel will have the net effect of reducing the maximum gain of the control axis by 50%. This gain level is adequate for control in the reaction region and up to about 120,000 ft. altitude in the aerodynamic region.

As an additional precaution, each adaptive channel is paralleled by a fixed gain channel, set at the lowest critical gain (the gain for high speed, low altitude control) in the flight envelope. These channels provide an emergency backup system which permits the aircraft to be kept under control if the adaptive channels fail. The fixed gain channels are continuously operative to eliminate switching delay should adaptive channel failures occur.

The system contains provisions which prevent execution of violent maneuver (hard-over) commands resulting from system malfunction. A spurious hard-over command in the automatic guidance mode will revert the system to the stability augmentation mode. Limiters will switch out hard-over signals from gyros, accelerometers, or stick and rudder pickoffs. The system will then operate as if a no-signal failure had occurred. A hard-over signal resulting from malfunction in an adaptive channel will cause the erring component to be switched out or, at worst, both adaptive channels of that axis to be disengaged. The fixed gain channels will then provide adequate damping for control of the aircraft. These provisions do not prevent the pilot from commanding a hard-over; if redundant channels or input signals are in agreement, system permits the maneuver.



DECCA NAVIGATOR'S Omnitrac computer allows use of a simplified rectilinear map, with automatic map-changing capability, on the pilot's presentation. Map shown here records a test flight July 31 around London-Heathrow area. The holding pattern for the test flight was set up at Mayfield (bottom).

Decca Flight Testing Omnitrac Digital Computer Navigation Unit

London—Decca Navigator Co. is flight testing a lightweight digital computer which, by translating hyperbolic coordinates into rectilinear terms, allows pinpointing of an aircraft's position on a conventional chart, rather than a distorted pilot's presentation as used in the present Decca flight log.

Company officials said the Omnitrac computer, although still a hyperbolic unit, computes the aircraft's precise position on the rectilinear grid, instead of on the curved line chart, which was a major criticism of the basic Decca system.

Omnitrac, combined with the Decca system, will be evaluated by Eurocontrol. System, called Harco (AW Oct. 30, p. 38) will be developed jointly by C.F.S. of France (Compagnie General de Telegraphie sans fil of France), Decca Navigator, and Telefunken, of Germany. U. S. firm of Teleregister also is cooperating.

New Improvements

Decca cited these new improvements, through use of Omnitrac:

• **Automatic flight log** in the cockpit, to reduce the pilot workload. Pushbutton sets the tracking needle on the end of the runway, as shown on the log, rather than placed by hand with possible resultant errors.

• **Maps can be changed** in 12 sec., also automatically. Six seconds are needed to transfer data to a memory store, and another six to set up new data. Pilots previously have complained of complexity in changing flight log to new maps.

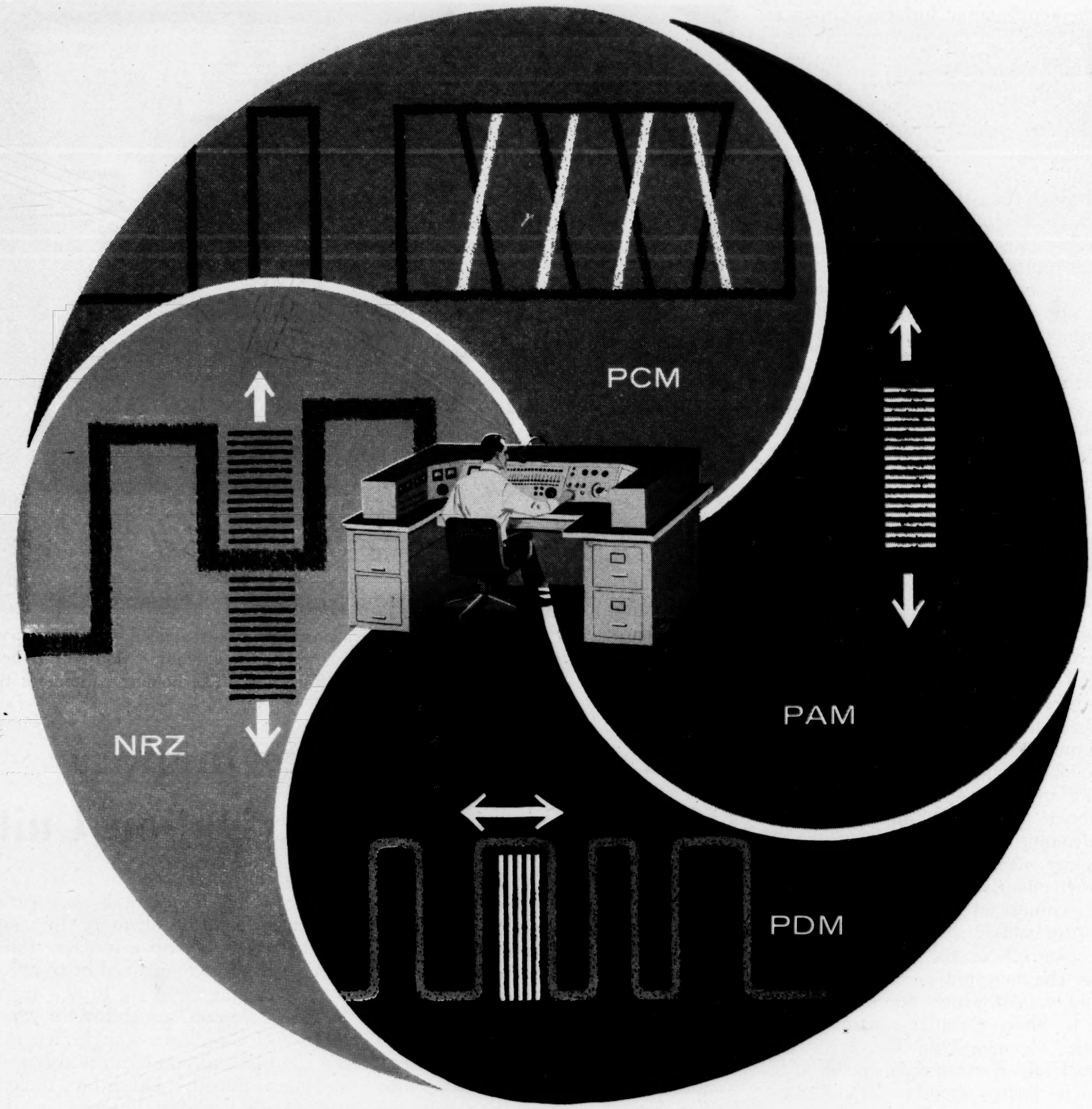
• **"Ghost Beacon" capability,** in which any set of coordinates can be fed into the computer and pilot can read bearing and range directly. Decca says there is considerable military interest in this factor. In addition, unexpected diversions in flight are less of a pilot problem, due to the automatic map changing factor.

Omnitrac Weight

Omnitrac, of which one prototype is flying in Decca's Vickers Valetta flying laboratory, weighs 50 lb. and measures 10 in. x 8 in. x 20 in. As the Harco system, it would cost about $19,000 installed in an aircraft.

Prototype uses a memory drum with 32 tracks, but a follow-on model now being developed would replace this with core storage, and total weight will be cut to about 30 lb. H. F. Schwartz, Decca Navigator's managing director, said this version will be in production by next summer. Fully-automatic flight log (designated Mk. 3) will start flight tests in November.

Future developments also include



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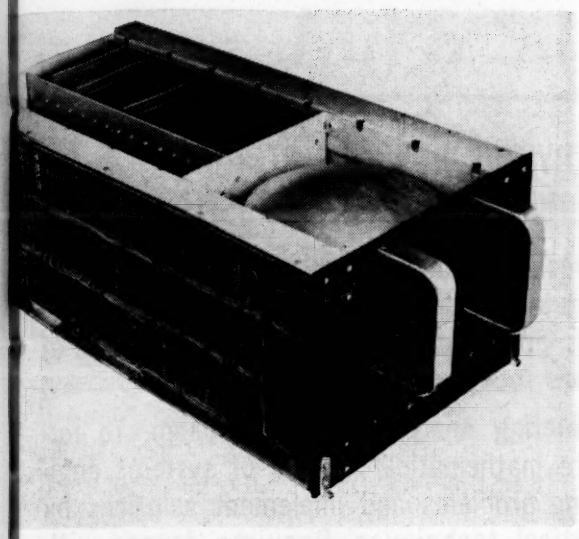

OMNITRAC COMPUTER unit is a digital coordinate converter, weighing 50 lb., which permits use of undistorted charts for cockpit presentation.

establishment of a direct link between the system and the autopilot and integration with doppler and inertial devices.

Eurocontrol operational specification calls for:

- **Operational track** with accuracy of ±2 naut. mi. and a position accuracy of not less than ±1.5 naut. mi.
- **Coverage from the ground** to 80,000 ft. altitude.
- **Cockpit pictorial presentation** providing continuous position information for ATC reporting.

Future Harco system development includes possibility of three-dimensional navigation in the airborne computer. Another potential is use of optical sensors in conjunction with the pictorial display to enable deviations from the printed track to be fed as corrective signals to the autopilot. This would permit flight along curved, as well as straight, tracks under automatic pilot control.

Decca said its Omnitrac system currently is being evaluated by British European Airways, for possible installation in its Vickers Vanguards this winter, pending Air Registration Board approval of placement of the Mk. 3 flight log in the cockpit. Basic Decca system now is used in BEA's Comets and Viscounts.

FILTER CENTER

▶**Auto-Tester Pays Off**—The 59th Fighter-Interceptor Squadron of F-102s, which placed first in its class with a perfect score (4,000 points) at recent Air Force William Tell Interceptor Weapons Meet at Tyndall AFB, Fla., was the only F-102 squadron to use an automatic test equipment, built by Radio Corp. of America for pre-mission check-out of its radar fire control system. The 59th FIS, headed by Lt. Col. Frank R. Jones, knocked down three of the seven drones hit during the meet. The squadron transported the 1,600 lb check-out system from its base at Goose Bay, Labrador. (For details on the RCA system, see AVIATION WEEK, July 11, 1960, p. 76).

▶**Space Surveillance Sensors**—Avionics industry may be asked to develop optical and electronic sensors for the Air Force's Global Surveillance System (SR 178) even if the current USAF evaluation concludes that the development of systems work be postponed on the projected manned, maneuverable orbital space vehicle surveillance system. Air Force is expected to decide by the first of the year exactly how it wants to proceed in this program (AW Oct. 16 p. 23). One evaluating agency has urged that work on sensors be initiated but recommended that spacecraft development be shelved.

▶**NASA Seeks Digital Instrumentation System**—Marshall Space Flight Center will soon begin evaluating industry proposals submitted last week for a digital instrumentation system, probably to be used for reading out measurements made on large, liquid space boosters. Proposals were due in Huntsville on Nov. 18.

▶**Klystrons for Nike-Zeus Radar**—Sylvania Electric is constructing large klystrons for use in the data acquisition and discrimination radars that will be employed in Nike Zeus anti-missile missile test firing from Kwajalein next summer.

▶**More Ion Propulsion Funds**—Air Force may soon grant additional funding, possibly near $1 million, for development of ion propulsion engines at Electro-Optical Systems.

▶**USAF Steps Up Penetration Aid Studies**—Raytheon and Sperry Gyroscope are working on separate Air Force studies of the use of electronic countermeasures systems as penetration aids. The Raytheon study centers on active electronic systems.

▶**Space Radiation Effects Analysis**—Analytical study of physiochemical changes produced by space radiation is being conducted by Electro-Optical Systems under a $15,000 contract from the Air Force's Space Systems Division.

▶**IBM to Build Thin-Film Facility**—International Business Machines Corp. will build equipment for high-volume production of thin-film assemblies using automation techniques under Navy Bureau of Weapons contract for $506,861. Equipment, to be delivered in a year, will be installed at Naval Avionics Facility, Indianapolis (NAFI). (For report on IBM thin-film program, see AW July 4, 1960, p. 82.)

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Does this type of setup appeal to you? For more information, write C. F. Gieseler, Dept. 114.

Organic Chemist—Propellant development research involving synthesis of basic monomers, plasticizers and organic compounds. Requires an advanced degree in organic chemistry with a knowledge of advanced organic synthesis. Experience in synthesis of reactive compounds is most desirable.

Research Processing Chemist—For laboratory investigations of polymeric materials that may be used as liners, and adhesive or encapsulating agents, and allied research. Strong background in organic chemistry and synthesis including a degree in chemistry or chemical engineering is necessary.

Aerothermo Specialist—Will perform heat transfer thermodynamic and aerodynamic studies on rocket motors, develop new methods of analysis and design tests. Will consult with designers and project engineers on major engine programs. Requires masters degree in mechanical or aeronautical engineering and 4 years experience in thermodynamics and heat transfer.

All qualified applicants considered without regard to race, creed, color or national origin.

Airborne Slam Range Stations Proposed

By Russell Hawkes

Las Vegas, Nev.—Airborne missile range stations are being proposed to observe and control Slam nuclear ramjet missiles if and when they reach the flight test stage of development, Ling-Temco-Vought technologists said at the Aerospace Nuclear Propulsion Symposium here.

Vought, study contractor on Slam, acquired missile range operating experience during Navy's Regulus I and Regulus II/KD2U test program on the old inland range of the Pacific Missile Range system.

Dr. W. J. Hesse and L. J. Boyer of Vought pointed out that the nuclear cruise missile will pose a number of difficult operating problems not found in ballistic missile programs. These are created not so much by the radiation hazards as by the range and maneuverability of the missile. Unlike ballistic missiles, a cruise missile with a guidance failure can change course far downrange where the ability of ground stations to take corrective measures may be problematical. Unlike chemical-burning cruise missiles, the nuclear ramjet can fly so far that a runaway would be a hazard to populated areas over a large part of the earth's surface.

Flight Essentials

From these facts, Hesse and Boyer have concluded that absolute essentials for peacetime nuclear ramjet flight operations are:

- **Full-time**, line-of-sight radar tracking.
- **Radio-command control.**
- **Multiple fail-safe** flight termination or destruct systems.

These essentials can be provided by a large number of ground-based or water-based range stations with tracking, command and control equipment, or by a relatively small number of specially equipped airplanes. Vought engineers believe the latter approach to be the cheaper and more effective way. A similar but less extensive method was employed when fighters were used as control planes in visual contact with the Navy-Vought Regulus turbojet cruise missiles. Missile runaways occurred in the Regulus I program when very little experience had been acquired by industry and Navy, but more than 100 flights of the Regulus II have now been made without a runaway.

Line-of-sight coverage of a missile flying at an altitude of 500 ft. is 40 mi. from a ground station with an antenna at 100 ft. Line-of-sight range is increased to 240 mi. from an airborne station at an altitude of 30,000 ft. Coverage of an airborne range system is also increased by the ability of the entire system to move downrange at a substantial speed. Even for high-altitude tests these factors reduce the number of range stations needed to one-seventh of the number needed if stations are on the surface. Presumably, cost reductions would be even more impressive because of the savings in personnel living expenses, transportation, real estate and communications networks. Hesse and Boyer said that a system of airborne range stations supplemented by a few surface stations is the most practical arrangement.

Transferring Control

A key problem is the transfer of control from one station to another as the missile proceeds downrange. There must be an over-lapping zone of control to assure that each new station can function properly before the earlier station relinquishes control. Vought studies indicate that the new station checkout would take about 20 sec. If the transfer cannot be made, the overlap zone must be wide enough so that the missile can complete a turn without passing beyond the first station's range of control. Apparently, the width in miles of the overlap zone must be largely dependent on the relative velocity of the range stations and the missile and is minimized when both range stations are paralleling the missile at a large fraction of its speed.

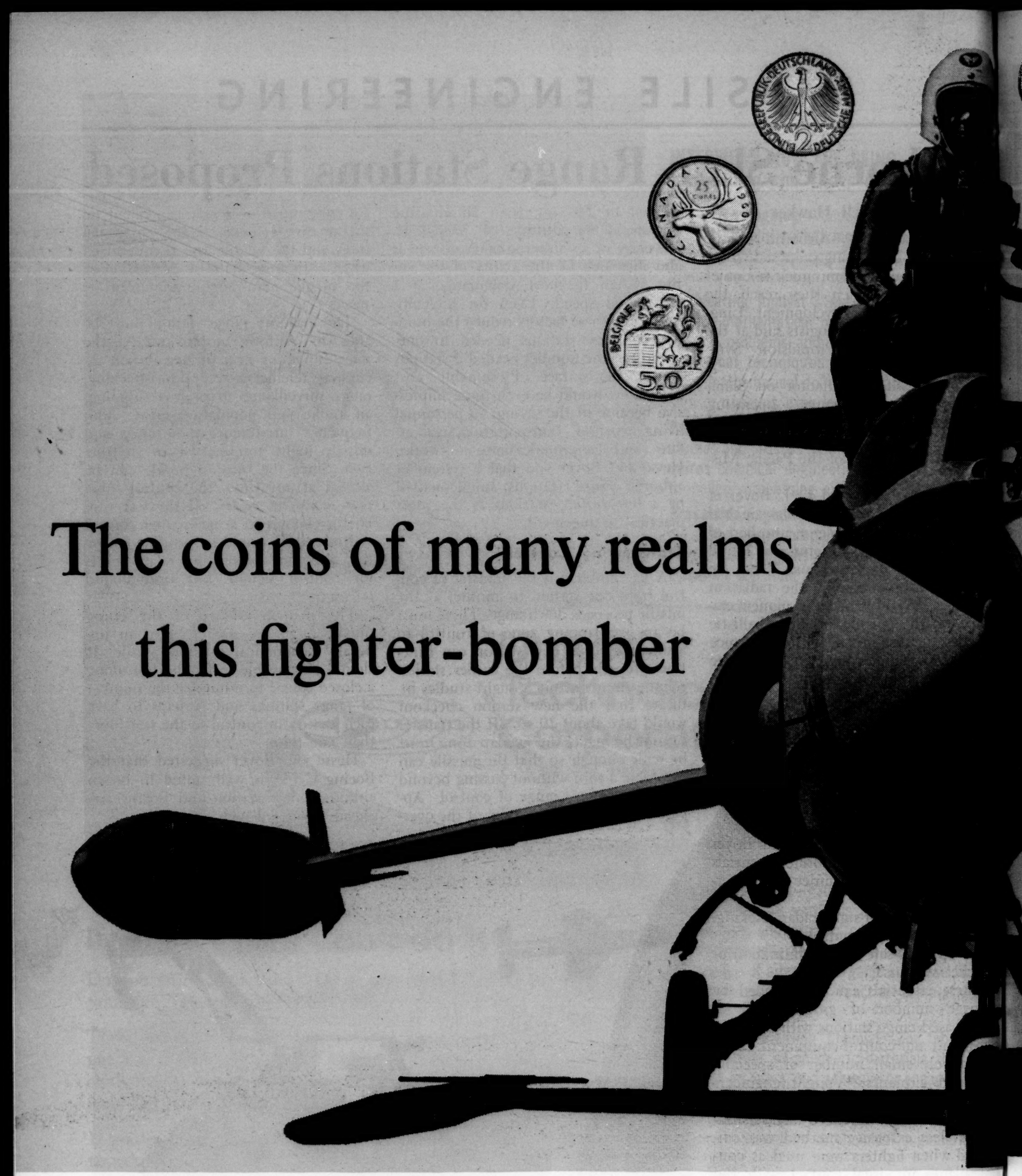
The airborne range station must be able to perform approximately the same functions as a surface station including telemetry reception, tracking, range surveillance to protect shipping, air traffic and population areas, radio frequency interference monitoring and missile flight termination or destruction. Since the mission profile can be altered at any time, the control function is also necessary. If the test conductor chooses to keep mission control centralized, it would be possible to use the airborne stations as relay points for control signals and air-to-ground telemetry.

The maneuverability of the cruise missile might be used to give an unusually economical mission profile. It should be possible to fly the test along a closed course to minimize the number of range stations and perhaps to have each station in control of the test more than one time.

Hesse and Boyer suggested that the Boeing C-135 is well suited to be an airborne range station and Boeing has already proposed such a version.

Malkara Fired From Armored Car

Malkara anti-tank missile is fired from a new air transportable armored vehicle made by Wharton Engineering for Royal Armoured Corps. Vehicle has a three-man crew; launcher arm, carrying two Malkaras, is hydraulically operated. Two more of the anti-tank missiles are stored within the armored vehicle.

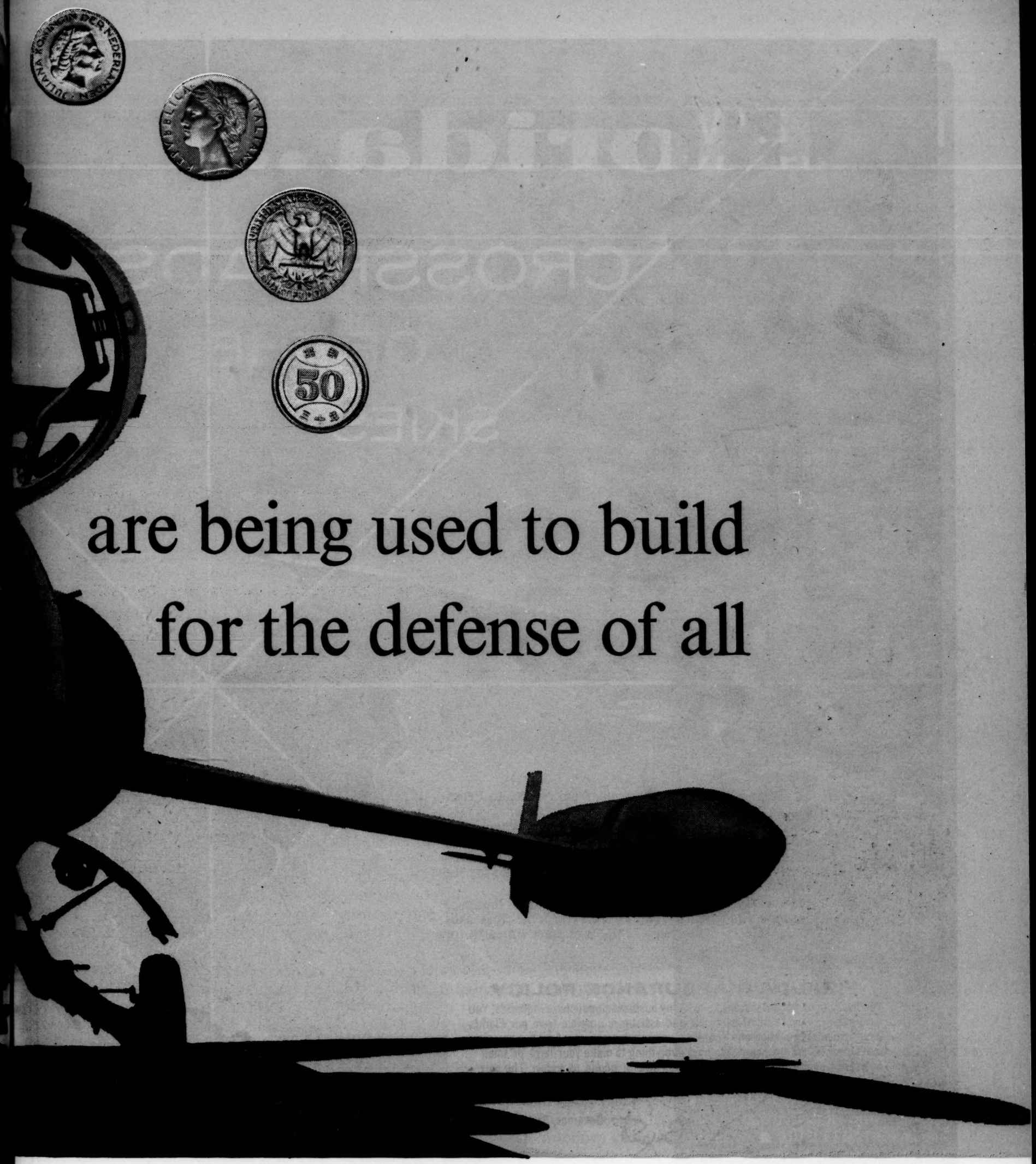


The coins of many realms this fighter-bomber

With their own money, seven Free World Nations—Belgium, Canada, West Germany, Italy, Japan, The Netherlands, and the United States—are building this airplane in their own factories.

It is the Super Starfighter, a much-advanced version of the original U.S. Air Force F-104. It is the best multi-mission aircraft in the world today.

By simply changing black boxes and weapons, the Super Starfighter can be converted quickly from fighter-bomber to interceptor . . . or strike bomber . . . or reconnaisance plane. It comes amazingly close to matching the big single-mission jets at their specialties. Yet it's a small, single-engine jet—cheaper to build, operate, maintain.



are being used to build for the defense of all

It gives our allies *one* plane that will meet *any* situation for the next 10 to 15 years. It also gives them the advantages of interchangeable parts, planes, even pilots—and of worldwide production.

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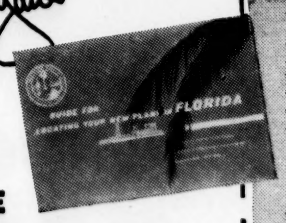

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FIRST JETSTAR to go through Horton-Horton custom shops was owned by Krupp firm of Germany. Airplane was given custom interior and new paint scheme in five weeks.

Custom Firm Expects Light Planes To Offset Drop in Corporate Work

By Erwin J. Bulban

Ft. Worth, Tex.—One of the country's leading business aircraft service organizations plans to expand its current market by moving into the customizing of light aircraft from small twins downward. The move is being made, according to the company, in order to counter trends that it says adversely affect companies specializing, as it has, in the heavy multi-engine executive fleet.

William L. Horton, co-owner with wife Dorthe Anne of Horton-Horton and Inter-America Aviation modification center at Meacham Field here, made these points in explaining the decision to diversify:

• **Much of the cream** of the market—servicing the large fleets belonging to corporations—has been dwindling over recent years, primarily because these owners gradually have been building up their own maintenance facilities and taking their business out of circulation for long periods of time. As an example, the Hortons pointed out that the four-plane Goodyear Tire & Rubber Co. Lodestar fleet, on which they are completing a major overhaul, modification and cabin interior program, probably won't require extensive outside service needs for approximately five years and by that time the corporation may decide to retire these aircraft for newer types.

• **Competition has become** increasingly serious from a number of local service airlines soliciting major airframe and powerplant overhaul business from executive aircraft owners, particularly those who operate equipment similar to these carriers, such as Convairliners, DC-3s and even F-27s. Business aircraft service operators are bitter over this development, bringing up the point that these carriers for the most part are subsidized by the federal government and often receive far better discounts on parts—tending to give them a bargaining advantage over the specialized private service bases.

• **It appears** that "the blush is off the rose" concerning sales of the first round of large turbine-powered executive airplanes and firms specializing in aircraft interiors can look forward to sharp declines in deliveries of this class of airplane, industry sources indicate.

Horton feels that now is the time to move into performing the same kind of service work on the smaller business plane fleet that the company has specialized in on the larger, 12,500-lb.-class and up, and that the new business will dovetail neatly with the present operation.

As he points out, in buying materials for aircraft interiors, it is impractical to purchase to the precise yardage that might be needed for a particular airplane, and "that's where your profit lies, in your stockroom," in referring to overage. He feels that sufficient extra materials are left over from big plane interiors to provide adequate coverage for small airplanes with interiors customized to the owner's specifications at "bargain basement prices."

Custom Treatment

This custom interior treatment, combined with a new exterior, such as special paint schemes and updating modification programs, fits right in with Horton-Horton's planned tactic of "obliterating obsolescence."

Because of the materials revolution in recent years—embodying the use of synthetics, lamination, silk-screening

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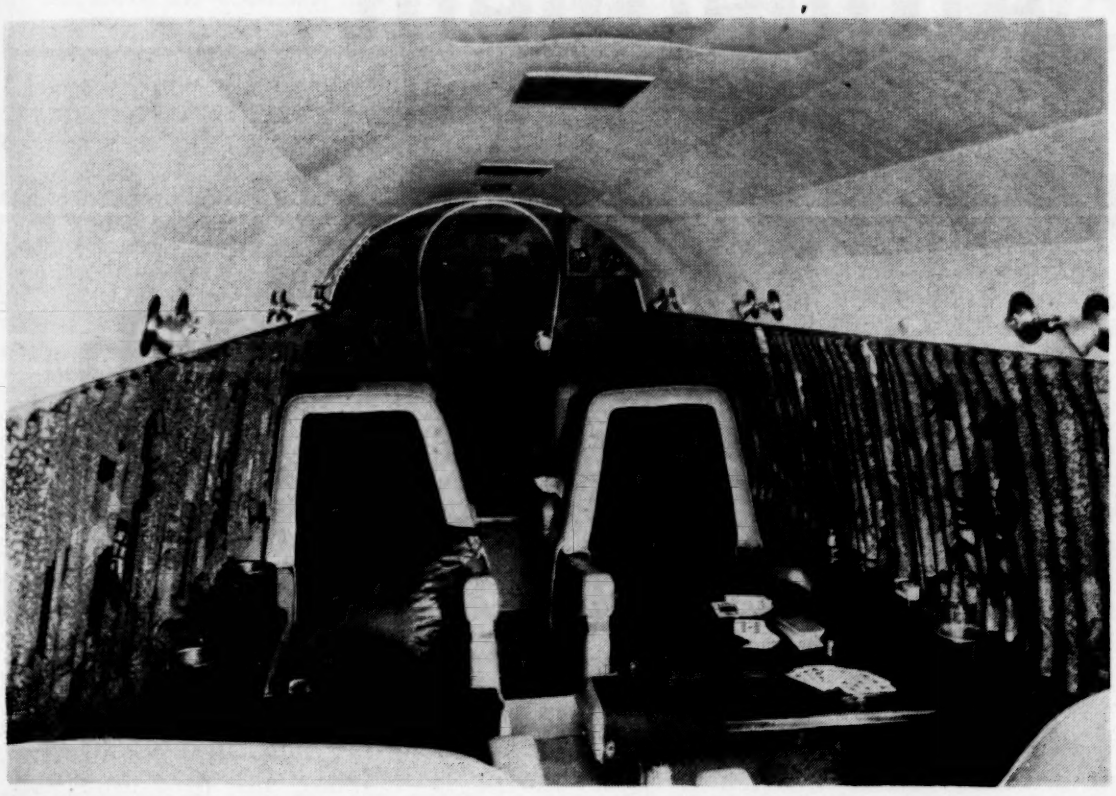

INTERIOR IN DE HAVILLAND DOVE owned by Whitfield Pickle Co. cost approximately $7,000 and demonstrates how low-cost materials can dress up business airplane.

and other techniques, using honeycomb for paneling, foam rubber cushioning in place of steel spring or normal rubber, aluminum framing, and anodizing metals to give rich gold or other finishes –plane owners now get lighter and even more exotic interiors at less cost than possible a decade ago. Horton estimates that interior costs have probably been halved because of the superior materials and know-how available today.

A JetStar interior can cost from approximately $35,000 to twice that, depending upon what the customer is willing to pay, although they probably will average out at approximately $50,000. But a good percentage of this cost is based on starting with a bare-hull airframe, as delivered from the factory, which means that much equipment such as emergency pop-out oxygen units are delivered uninstalled since their final placement will depend upon the seating arrangement decided on by the customer. Also seating generally will be built up from the start and have to be engineered to 9g or more requirements, with the cost for this running $600 or more per seat.

Smaller airplanes, such as the de Havilland Dove twin, can be redone for $7,000.

Scheduling airplanes through the shops, not only to try to maintain an even flow that beats the peaks-and-valleys situation, but to minimize downtime which is a major customer problem, is one of the tough areas that business aircraft conversions have to solve. Until the contract is finally signed that specifically outlines the program it is difficult to analyze just what will be involved. The new turbine-powered aircraft, posing new engineering problems because of their ability to operate at higher g loadings and FAA requirements that interior structures match these capabilities, add new delay factors to the conversion regime.

The company, however, recently surpassed its own schedule for completing its first JetStar, for the German firm of Krupp, by a week based on an early estimate that the job would take from five to seven weeks. The airplane went through the shops, including a complete paint scheme in four weeks four days.

Current contracts call for Horton-Horton to deliver four additional JetStars–the Harold S. Vanderbilt airplane and airplanes for Corning Glass, Canadian Breweries and Italy's S. N. A. M.

Concurrently, it has been converting a former Allison Division of General Motors' Lockheed Electra for the Los Angeles Dodgers, with 64 seats, dual galleys and two bunks, capable of sleeping four.

Also scheduled here is Slick Airways' first Canadair CL-44 swing-tail transport, configured to 150-passenger seating for handling Military Air Transport contract business and several DC-7s are also expected to be outfitted for a similar operation.

Better than two-dozen turbine executive airplanes already have gone through the shops including 15 F-27s, nine Gulfstreams and a Viscount. Piston-engine business airplane schedules include putting through an average of two Doves a month, one and one-half to two twin Beeches monthly, close to one Lodestar per month, and one or two Aero Commanders monthly.

Steady build-up in business is indicated by the last three years' record. The company indicated that the 1959 tally was $870,000, this rose to $1,038,000 in 1961 and they estimate that this year the total business will be over $2 million.

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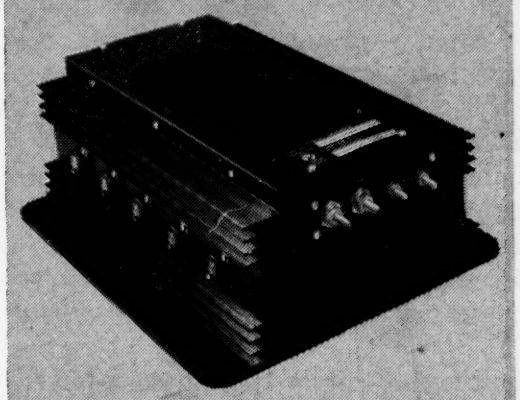

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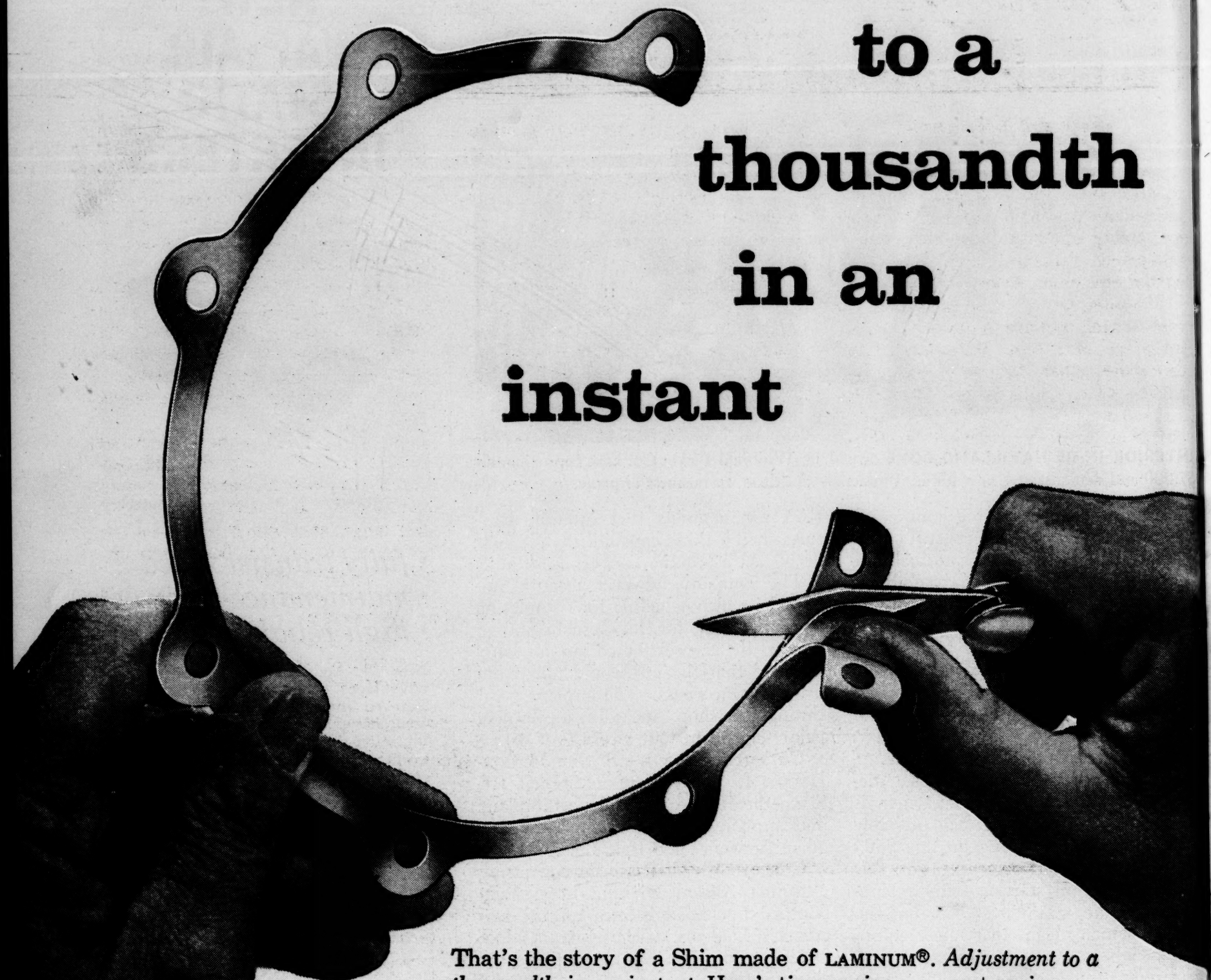

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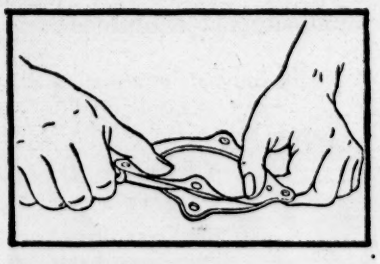

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Swiss Air Force—Part II

Swiss Emphasize Individual Pilot Abilities

By Cecil Brownlow

Bern—Swiss air force places major reliance upon the competence of the individual to compensate for the minimal flying hours and cramped, mountain-ringed practice areas available within this small, neutral nation.

Training, often beginning even before formal military induction, is demanding and only the ablest pilot candidates survive the rigorous weeding process to win their wings. "We have a small air force and our pilots must be good with the number of flying hours they get each year," one instructor explains. "We can't afford to pass a marginal pilot, and we're small enough to take only the best."

The competence demanded in gunnery and bombing trials also is severe, particularly for the reserve pilots who serve as the backbone of the air force and fly between 70 and 80 hr. each per year. Available land and water areas are relatively minuscule in size, more often than not prime tourist and/or fishing areas, and in a democracy such as this the protesting voices of aroused hotel and fishing boat owners can be strong and effective.

The annual air force-wide weapons meet held high in the Bernese Alps, as an example, is carefully timed in the fall when the summer mountain climber tourists have departed. The necessity of roping off lake areas for brief periods is carefully explained to those directly concerned.

Even so, the noise complaints of hotel owners are often loud, and the fishing boats sometimes seem to hedge as close to restricted areas as possible, bobbing serenely as aircraft dive in to direct bullets and bombs into target areas several hundred feet away.

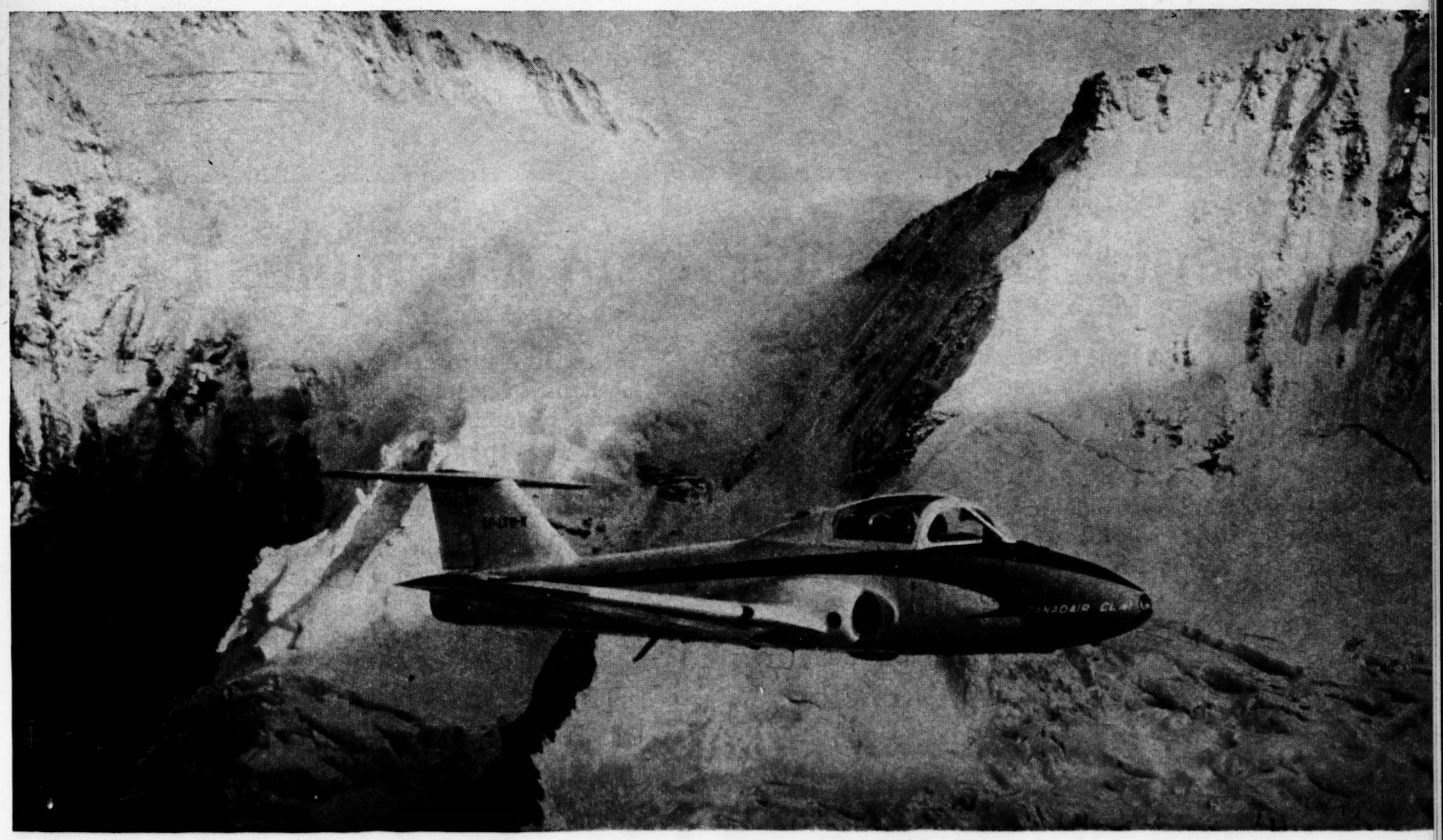
Fiscal restrictions prohibit an individual pilot from firing all four of his guns simultaneously on more than an average of once a year. Bombing and folding-fin rocket practice is similarly restricted.

Recently, eight reserve pilots, the majority sergeants, skimmed over a narrow sector of Lake Neuchatel, a Jura Mountain-hemmed body of water near Payern, the site of a major air force training field. It was their first target practice of the year.

Firing one of the de Havilland Vampire's four 20 mm. guns in a single burst of 20 rounds, each pilot stitched a respectable pattern into a small canvas-covered target, with an average of three to six bullets striking the target's center.

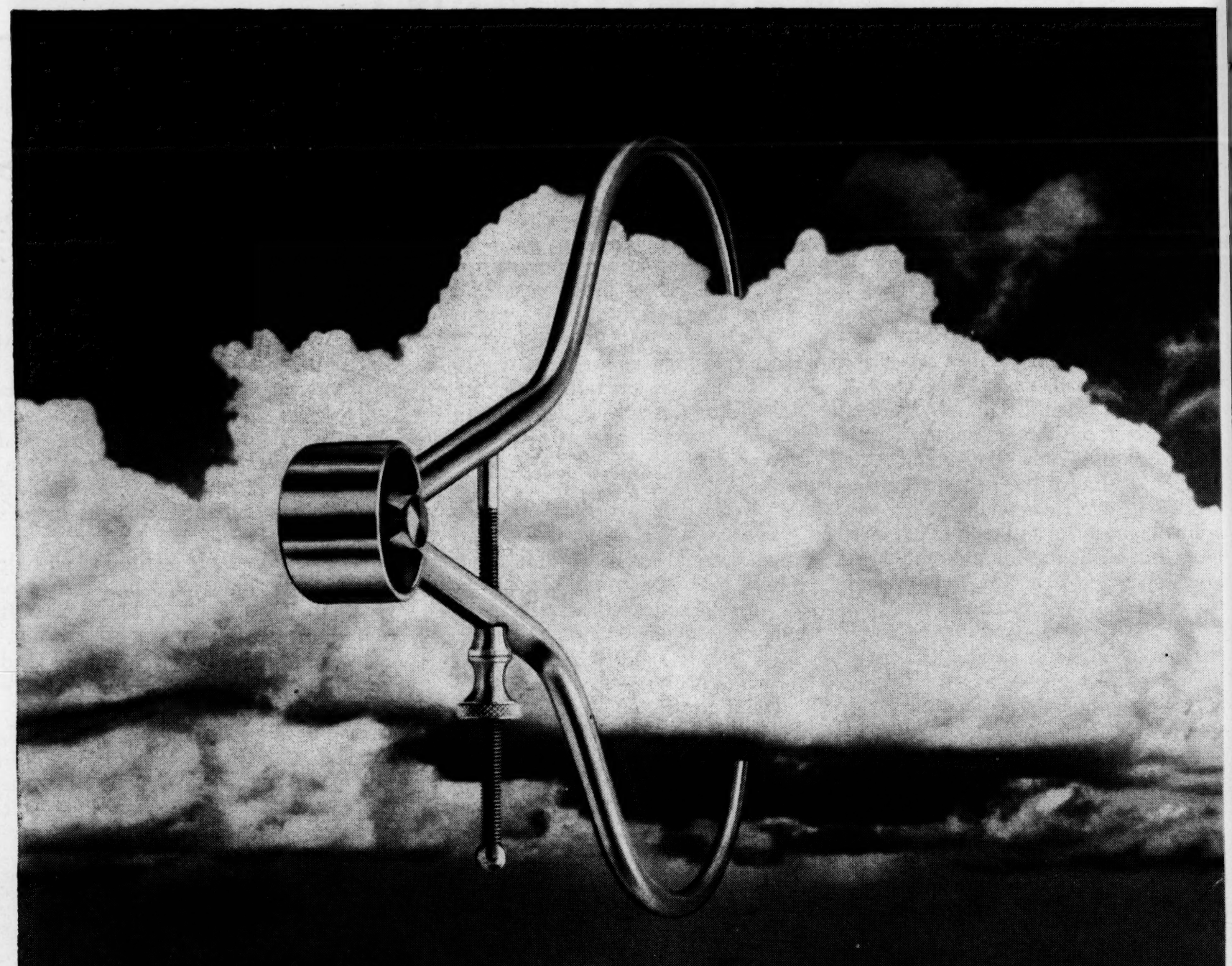
On a total of eight low-altitude bomb runs, only once did both projectiles dropped by a single aircraft land outside the rectangular, 100-ft.-long target area which had been laid out to represent the "kill" area of a 500-lb. napalm bomb.

In another demand on flying skill, all the combat fields used by these pilots are buried in the Alps, their runways sometimes crossing regular commercial highways and their hangars



CL-41 Jet Trainer Flies Over Alps

Canadair CL-41 jet basic trainer was photographed by Swiss air force while flying over the Alps during the aircraft's recent tour of Europe. The two-seat trainer, powered by a Pratt & Whitney JT12 turbojet engine, has been ordered by the Royal Canadian Air Force. The trainer recently reached Mach .775 in level flight, exceeding the RCAF requirement of Mach .75 (AW Nov. 13, p. 23).



Siegler puts calipers on a cumulus cloud

Siegler Cloud Height Radar, developed for USAF, *visually maps,* for the first time, not only height and horizontal dimensions but also *upper limits and density* of cloud formations directly over the airport—both critical factors in jet flight control.

Another urgent need—provision of accurate weather data with the *speed* essential in the jet age—is met by Siegler Automatic Electronic Weather Stations, also developed for USAF. This solid state equipment gathers, computes and transmits data for continuous and accurate terminal weather predication—in a minute fraction of the time required for manually processed data.

Meteorological capabilities are only one phase of Siegler versatility in electronics, metallurgy and electromechanics. Siegler participation in major aerospace programs includes ground and airborne communications and navigation aids, launch check-out, miniaturized solid state video systems, aerospace components and many other contributions.

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buried deep in the natural, nuclear radiation-resistant rock. High g take-offs and approaches through steep valleys with a mountain face at either end can be unnerving to the uninitiated, but the reserve pilots learn to accept them as a matter of course.

Ground support missions for mountain troops demand that the pilots adjust their altitude second by second as the terrain below gains in height and rises to meet the low-flying aircraft. Experience can be marginal but ability cannot.

The combat fields are minor fortresses in themselves, located in a circle rough and close enough to one another so that a line-of-sight microwave communications net can be maintained. Search radar antenna on the mountain tops can be retracted into the rock to prevent detection, hoisted up again for more sweeps once the danger has passed.

The hangars are stocked with the wartime needs of fuel, food, spares and ammunition.

To fit into this, and maintain his proficiency on his Hawker Hunter, Venom or Vampire, the reserve pilot annually spends six weeks on active duty: three weeks in ground support maneuvers with the army division to which his squadron is assigned, one week of gunnery at Payern and, finally, two weeks of formation flying, acrobatics, navigation flights, blind flying and general navigational training, probably at Dubendorf near Zurich.

Week-End Duty

In addition, he is expected to report for flying duties on an average of one week-end out of every three, carrying out largely on his own a specified flight syllabus for a given period. "A man who reports and doesn't know exactly what he is expected to do is not anyone we want," one professional officer says. "He has to study at home so that, when he reports, he knows what to do and then does it."

The air force flying experience also is often supplemented by a civilian job as pilot or copilot with Swissair. Of the normal year's output of between 35 and 40 new pilots, approximately 40% join Swissair, and another 30% remain to fill billets in the four full-time squadrons which make up the air force's ready alert contingent.

Here, to comply with the Swiss constitution which prohibits a standing military force, the pilots are paid as civil servants rather than as officers per se. And, although attracting some 12 recruits a year for this role, the open billets are difficult to fill.

"Those who want to make flying their career tend to go to Swissair where the pay is much higher and the idea of

PROBLEMATICAL RECREATIONS 93

In a room 40 feet long, 20 feet wide, and 20 feet high, a bug sits on an end wall at a point one foot from the floor, midway between the sidewalls. He decides to go on a journey to a point on the other end wall which is one foot from the ceiling midway between the sidewalls. Having no wings, the bug must make this trip by sticking to the surfaces of the room. What is the shortest route that the bug can take? — *Contributed*

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ANSWER TO LAST WEEK'S PROBLEM: The angle $a = \frac{\pi}{10}$ satisfies the relation $\tan 3a = \cot 2a$, i.e., $\frac{3 \tan a - \tan^3 a}{1 - 3 \tan^2 a} = \frac{1 - \tan^2 a}{2 \tan a}$, or $5x^4 - 10x^2 + 1 = 0$, where $x = \tan a$.

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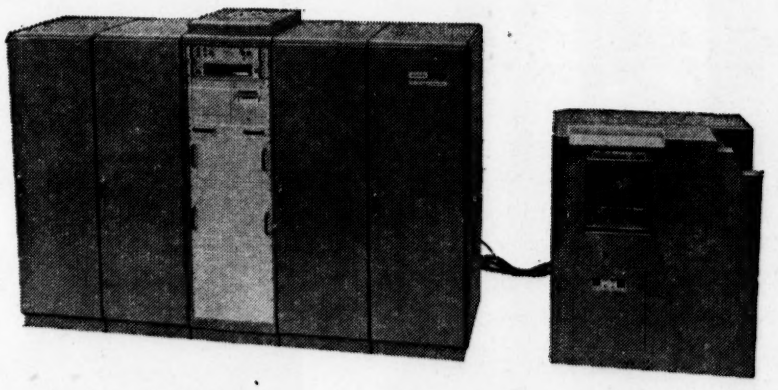

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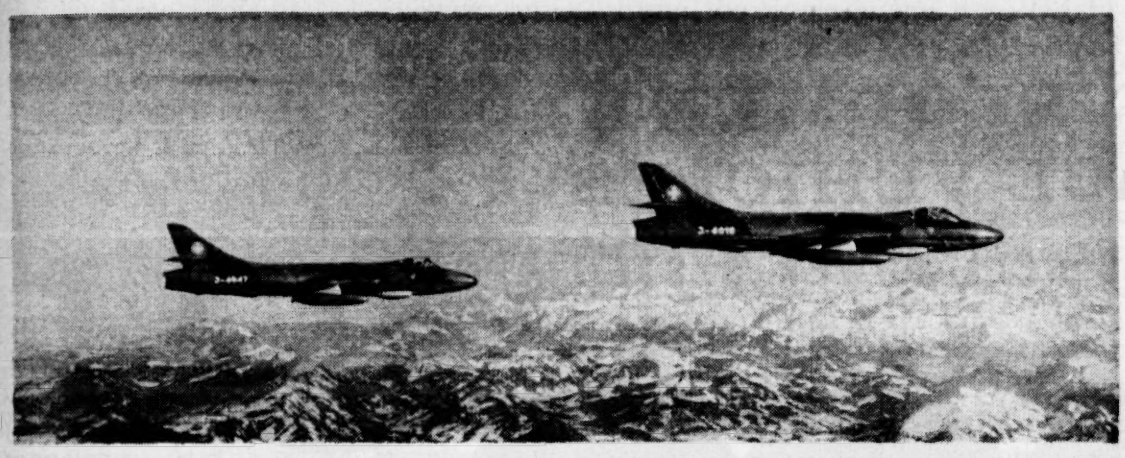


BORDER PATROL of Hawker Hunter aircraft, manned by Swiss air force reserve pilots who fly between 70 and 80 hr. a year, sweeps over the Alps.

visiting foreign cities is appealing," according to air force commander Maj. Gen. (Colonel Divisionnaire) Etienne Primault. "After six years with Swissair, he can be making a colonel's pay." The fiscal attraction, however, can often be combated by an appeal for the individual to help meet the country's defense needs by remaining in uniform.

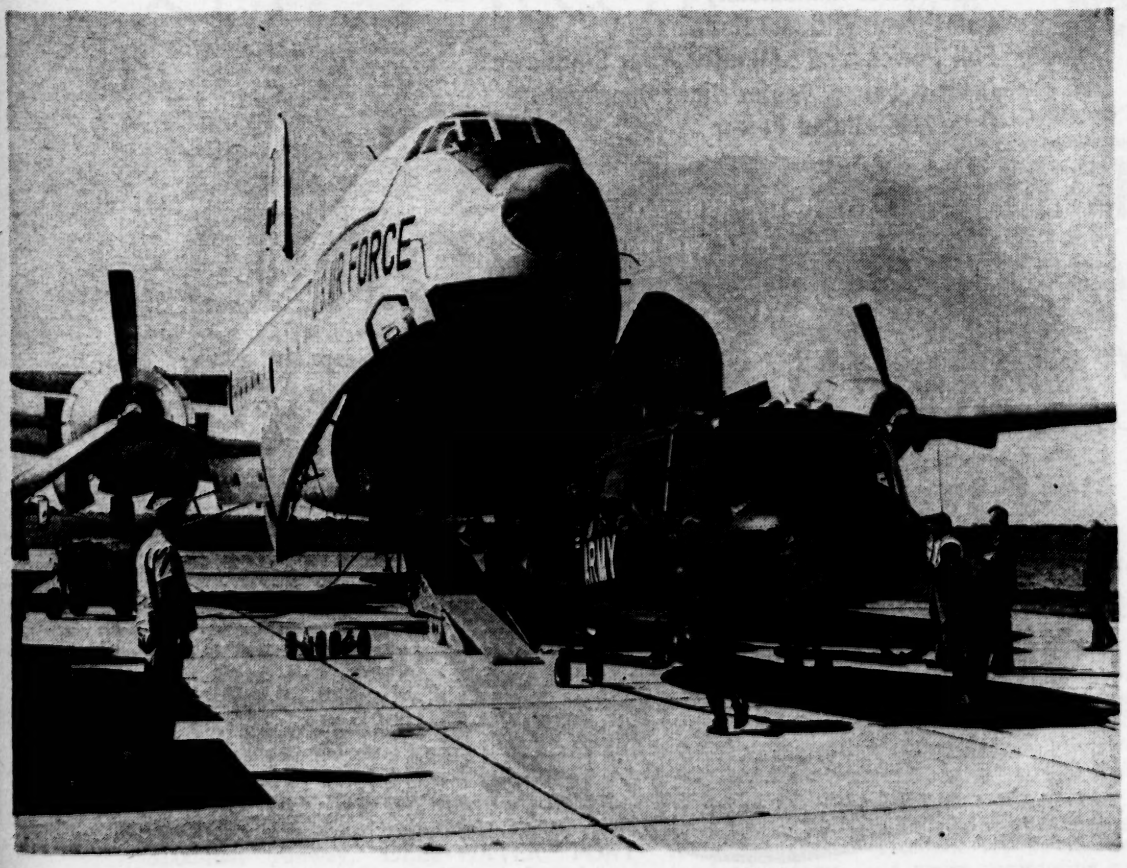
Training Program

A youngster interested in a pilot's career, reserve or professional, and willing to risk the odds against success, normally begins at the age of 17 by joining a state-supported civil flying club. Of the 750 to 1,000 applications each year, an average of 250 are finally approved for membership.

Over the next two years, he receives a total of four weeks of pre-military training, including between 10 and 20 hr. of instruction on a Piper Cub or other light aircraft. At 19, he is assigned to a specific service and, if his civil school record has been satisfactory, the assigning officer must acquiesce to the student's wish to join the air force.

Formal military service begins at 20, as it does for essentially all Swiss males. First stop is at Payern for nine weeks of recruit school and ground training. If he is to become a pilot candidate, he is advanced to primary flight school at Locarno; if not he remains at Payern for another eight weeks of ground technical training and subsequent duty with the technical or administrative corps.

Here, although 80-85% of the cadets have been through the civil school, there are usually a few who have never flown before and, on occasion, have never previously seen an aircraft on the ground—candidates from rural areas where the local governments could not otherwise meet their commitments to



Bell YHU-1D Loaded in Globemaster

Prototype Bell YHU-1D Iroquois helicopter, which has larger cabin and more powerful turbine engine than earlier versions, is shown being loaded aboard a Douglas C-124C Globemaster transport for airlift to Ft. Bragg, N. C. YHU-1D can carry 12 fully equipped troops, 50% more than previous versions and is powered by 1,100 shp. Lycoming T53-L-9 engine.

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The small aluminum globe in the picture is a bomblet Alcoa engineered and developed for the U. S. Army Chemical Corps. The tall tubes to the right are Zuni missile outer shells. The pieces that resemble chess rooks are center sections of the Air Force's Bullpup missile. The drums are chemical shipping and storage containers for the armed forces. The cylinders on the left are ammunition rack tubes for Army Ordnance's M-60 tank.

Not shown are rocket engine cases, flotation spheres, jet fuel filter-separators and scores of other defense items Alcoa turns out by the thousands.

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the air force. Familiarization flights in Swiss-made Pilatus P-3 primary trainers range, therefore, from a minimum of 4 to 24 depending upon the previous experience and aptitude of the cadet. The flights include acrobatics, normal landings, forced landings and aborted landing procedures.

Then, the commander of the school takes a check ride with the student, going through the entire syllabus. The cadet, to pass, must score at least eight points out of a maximum of 10 on each maneuver. At this point, average P-3 flight time for a student who has passed through a civil school is about 10 hr. If he is approved on his check ride, he is authorized to solo and flies another 25 hr. or so to finish his eight weeks.

For a student who began school at Payern in July, a normal starting month, the time would now be late October with its resultant fog, rain and general bad weather, and he would be duly dispatched back to civil life to await the new year and better flying conditions.

Afterwards, he would begin another 17 weeks of training—the first four at Locarno with its grass strip for "under-officer" school and promotion to corporal plus additional solo P-3 flights and then transfer to a base with concrete runways, Emmen, Sion deep in the mountains, or Meiringen, also mountain ringed.

From the single-engine P-3, the student advances directly to a two-seat jet fighter trainer, the DH-115 Vampire. For about eight weeks the cadet concentrates upon the DH-115, building up 45-50 hr. flying time. Then, he moves directly to the single-seater Vampire for another five weeks, accumulating about 15 hr. in the air with the remaining, and major, portion of the time spent in ground school studying the usual basics.

This is followed by another break and return to civilian life, usually for approximately five weeks. Another 17 weeks of active duty follow, with 12 spent on the Vampire and the remaining five on the single-seater Venom at Payern, including gunnery training.

Wings Awarded

Having persevered thus far, a student has accumulated between 200 and 250 hr. of flying time and earned his wings which bring with them the rank of sergeant pilot.

Of the 750-1,000 applicants at the age of 17, about 35-40 have made it through the course.

There is again another month's return to civil life followed by four short periods of active duty, each lasting one week, in which the pilot covers any phases he may have missed due to weather conditions—there are an average of 60 cloudless days in the Alps each year—additional Link trainer time, more gunnery, ground-controlled approach and instruments training, tactical exercises and formation flying.

At the completion of his Venom training, the pilot also is graded as to officer potential. As one instructor explains:

"Proposition A means that he is a very good man with a good record and should be sent to officers' school unless he makes a mess of his last four weeks training. [The instructor has seen this happen only once in the past 10 years.] Proposition B means that he is a good man but perhaps a little young or that he has a slight weakness somewhere."

The reference to youth surrounds the fact that a cadet can begin his service at the age of 19 rather than 20 if he desires, thus normally completing his pilot's training at 21 rather than the usual 22.

If a "B" candidate should improve during his four weeks of final training before being assigned to squadron service, or when he gains a year of age, he can be boosted to grade "A" and become immediately eligible for the 19 weeks of officers' school. Failing this, he also may subsequently be upgraded by his squadron commander and assigned to complete officers' training.

Normally, perhaps 50% of the graduating students gain the "A" stature, an-

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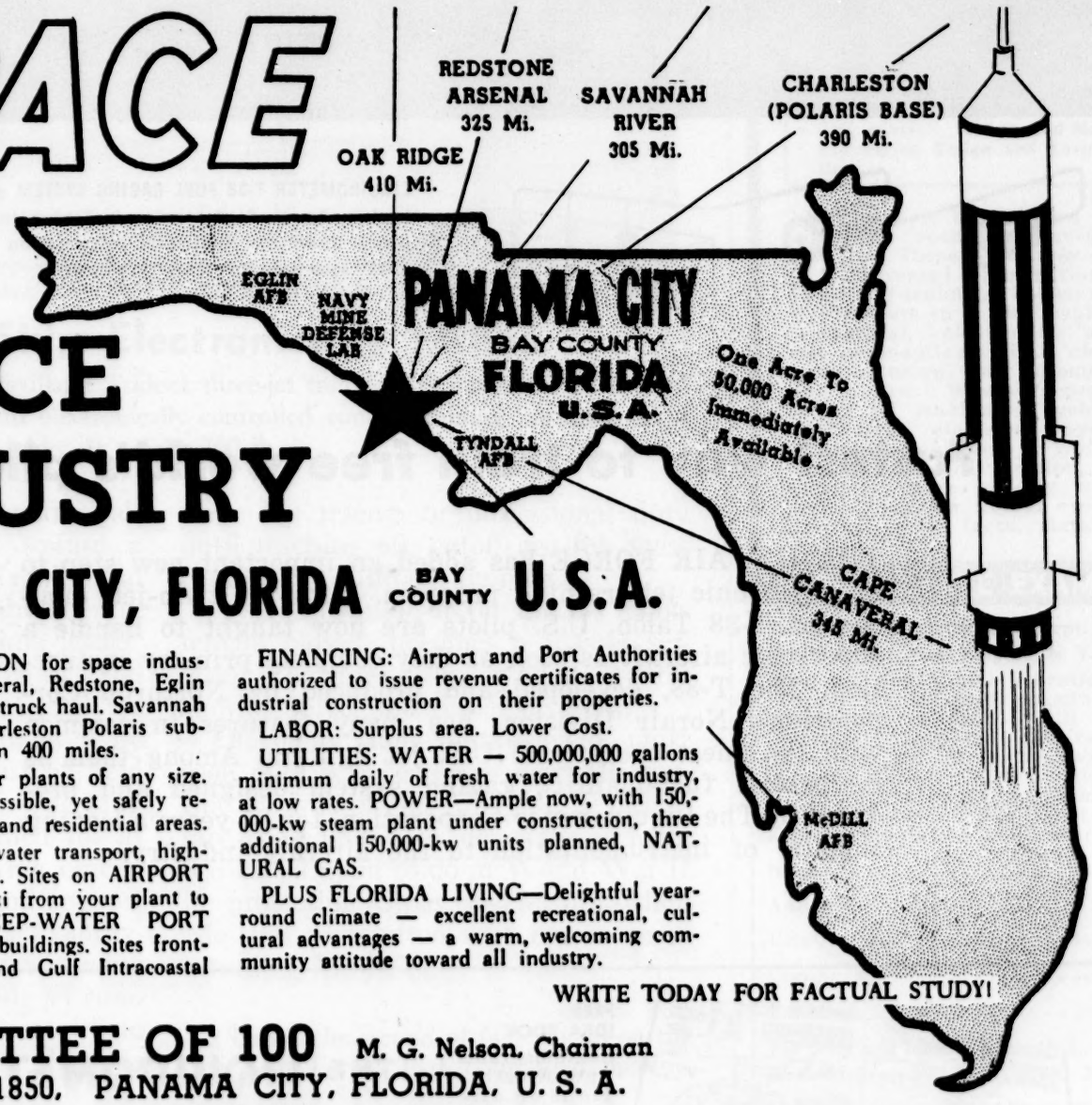

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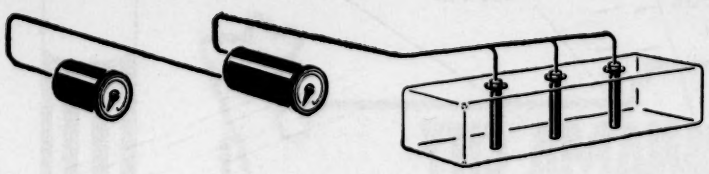

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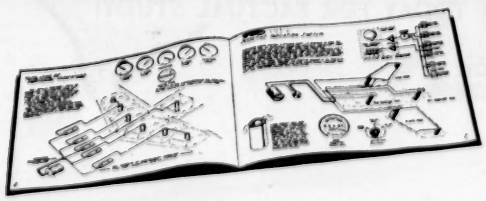

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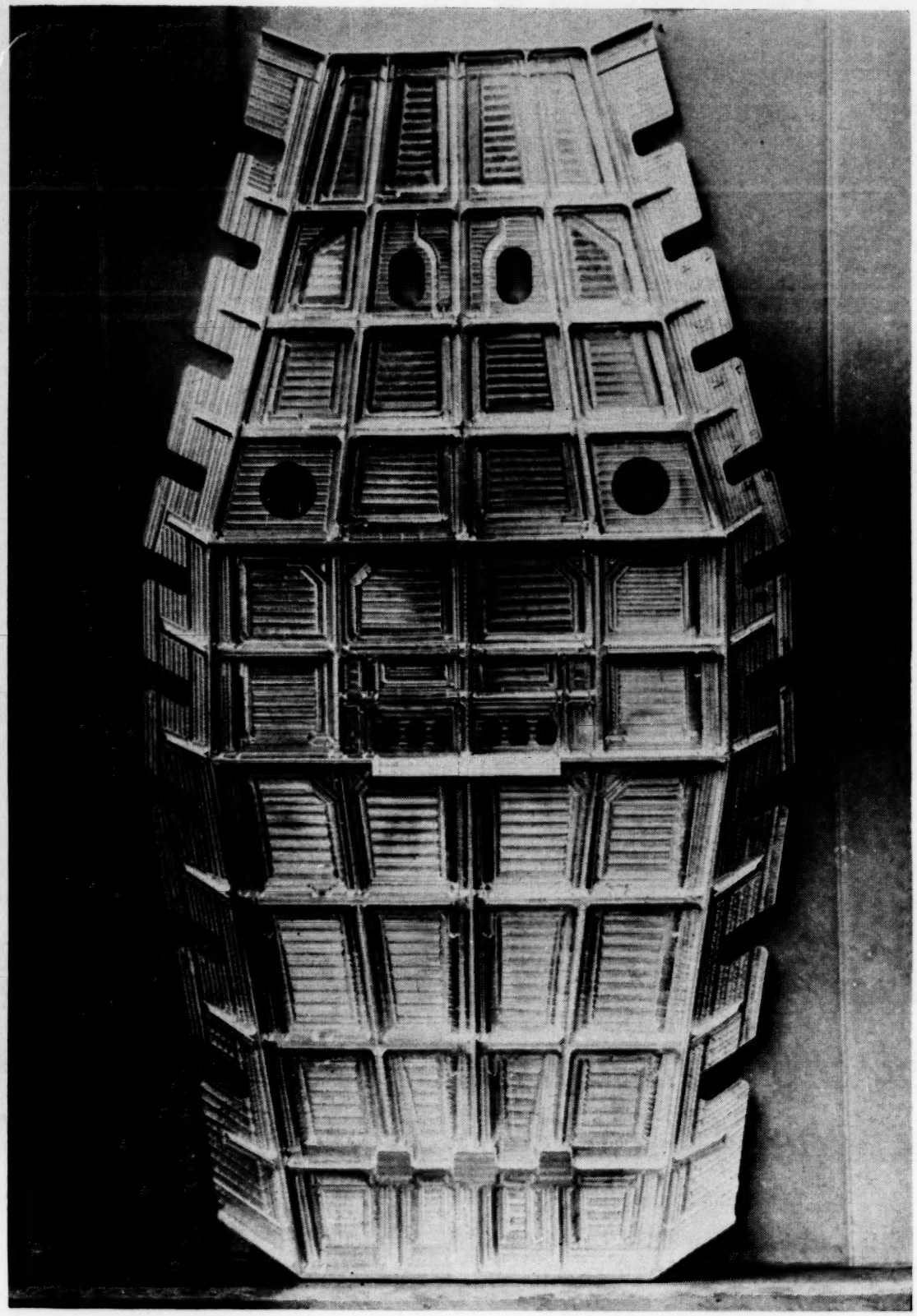

Tailplane Skin Electronically Milled

Top tailplane skin for the de Havilland Trident three-jet transport is machined from solid aluminum slab by Fairey/Ferranti electronically controlled contour milling machine. Skin is 7 ft., 1½ in. long x 4 ft., 1 in. wide. It weighs 200 lb.

other 20% "B." The remainder, although normally channeled toward a life in the non-commissioned ranks, also can improve their status if subsequently recommended by their squadron leader.

For the commissioned officer, the rank of base lieutenant is retained for approximately three years, followed by a first lieutenancy which must be held for a minimum of two years. The rank of captain is generally retained for at least eight years—six as a flying officer, two with the army as a ground support officer. Then, if he attains a majority, he can return to the air force as a wing commander and continue flying jet combat missions until the age of somewhere between 45 and 50. After this, he would be assigned a staff post and continue his reserve or professional duty until reaching 60, cutoff age for Swiss compulsory military training.

A sergeant pilot, if the officers' ranks remain closed, becomes a master sergeant after three years, an adjutant after another three, and this is his apex.

Officer or non-commissioned rank, each pilot is expected to meet the routine hazards of the Alps and, if necessary, those of any invader as the air force was called upon to do in World War II in protecting Swiss sovereignty when Me-109s were often sent out to meet intruding Me-109s.

(This is the second of two articles on the Swiss Air Force. Part I appeared in Nov. 13, issue, p. 54).

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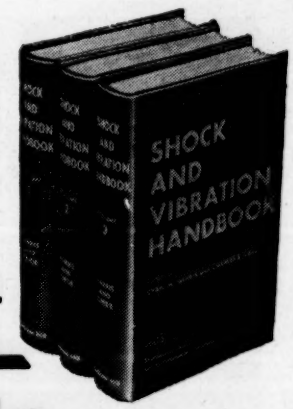

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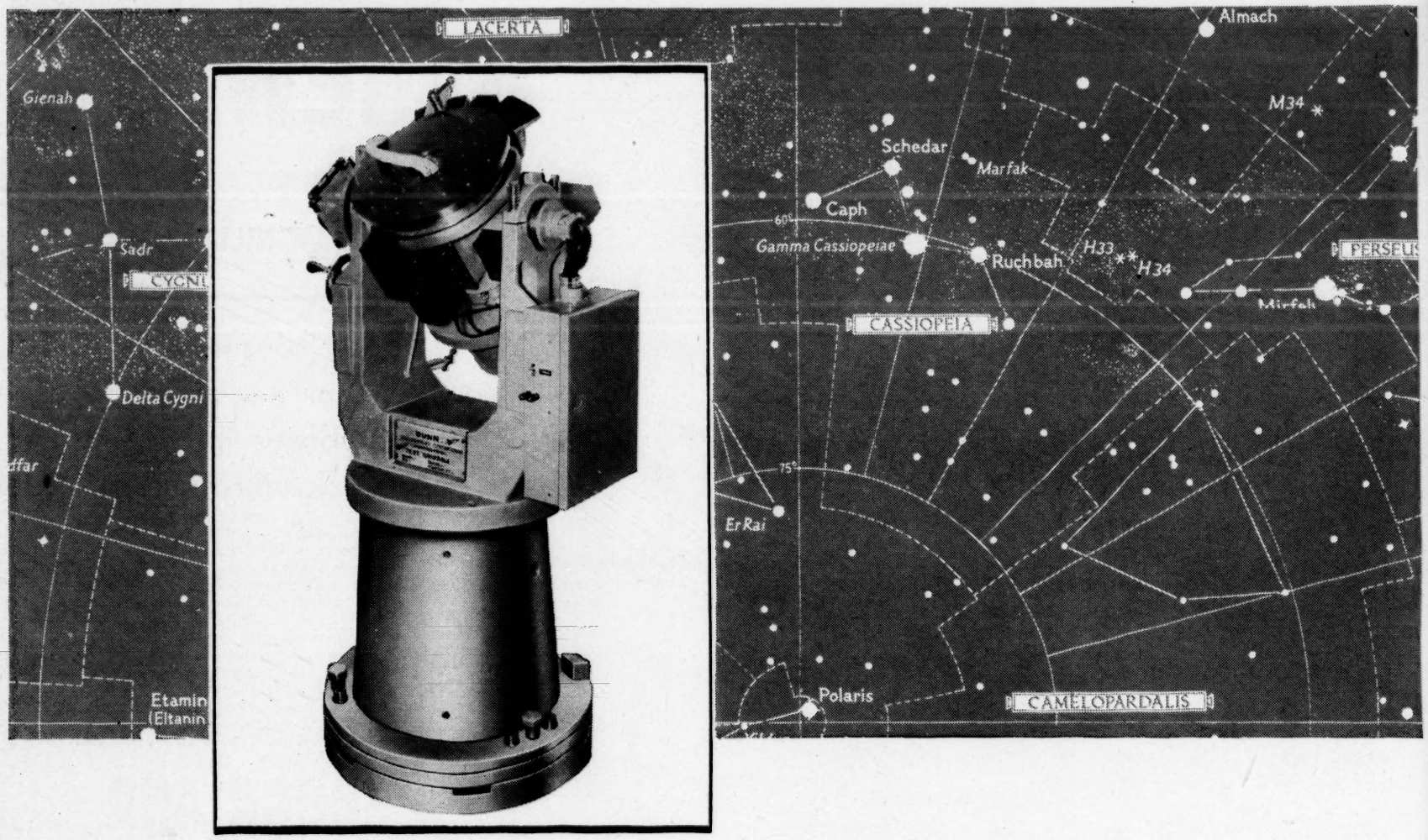

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(*Continued from page 23*)

Changes

Capt. I. F. M. Newnham, manager, Precision Engineering Division, Short Brothers & Harland, Ltd., Belfast, Ireland.

Dr. Roger W. Strassburg, manager-research operations, The B. F. Goodrich Co.'s Research Center, Brecksville, Ohio.

C. A. Zraket and **D. R. Israel,** technical directors, The Mitre Corp., Bedford, Mass., and **D. R. Brown** and **K. E. McVicar,** associate technical directors.

Gaylord W. Newton, consulting specialist-marketing, General Electric Co.'s Large Jet Engine Department, Evendale, Ohio.

Richard Edwards, technical liaison representative in Grumman Aircraft Engineering Corp.'s newly established business and technical liaison office, Los Angeles, Calif.

Martin J. Leader, manager of contract administration, ACF Electronics, Riverdale, Md., a division of ACF Industries, Inc.

Stanley Schwalbe, manager of engineering planning, Polarad Electronics Corp., Long Island City, N.Y.

Marshall S. Johnson, chief of the newly created Space Flight Operations Section, Systems Division, California Institute of Technology Jet Propulsion Laboratory, Pasadena, Calif.

Dr. Henry M. O'Bryan, scientific assistant to the vice president of engineering and research, The Bendix Corp., with offices in Washington, D. C.

Harry W. Burdett, Jr., manager of planning, American Machine & Foundry Co.'s Government Products Group, New York.

James Richard McCharles, manager, Guidance and Controls Division, Hughes Aircraft Co.'s Aerospace Group, Culver City.

Joseph Oppenheim, director of programs management, Raytheon Co.'s Electronic Components and Devices Group, Lexington, Mass.

Fulvio de Laval, European representative for The Marquardt Corp., with headquarters in Rome, Italy.

Dr. David J. Mann, director of research, Reaction Motors Division, Denville, N. J., of Thiokol Chemical Corp.

Leonard I. Sherry, assistant to the director of advanced engineering, Defense Products Division, Fairchild Camera and Instrument Corp., Syosset, N. Y.

Paul G. Schultz, director of engineering, Huyck Systems Co., Huntington, N. Y., and **Paul F. Helweg,** marketing manager.

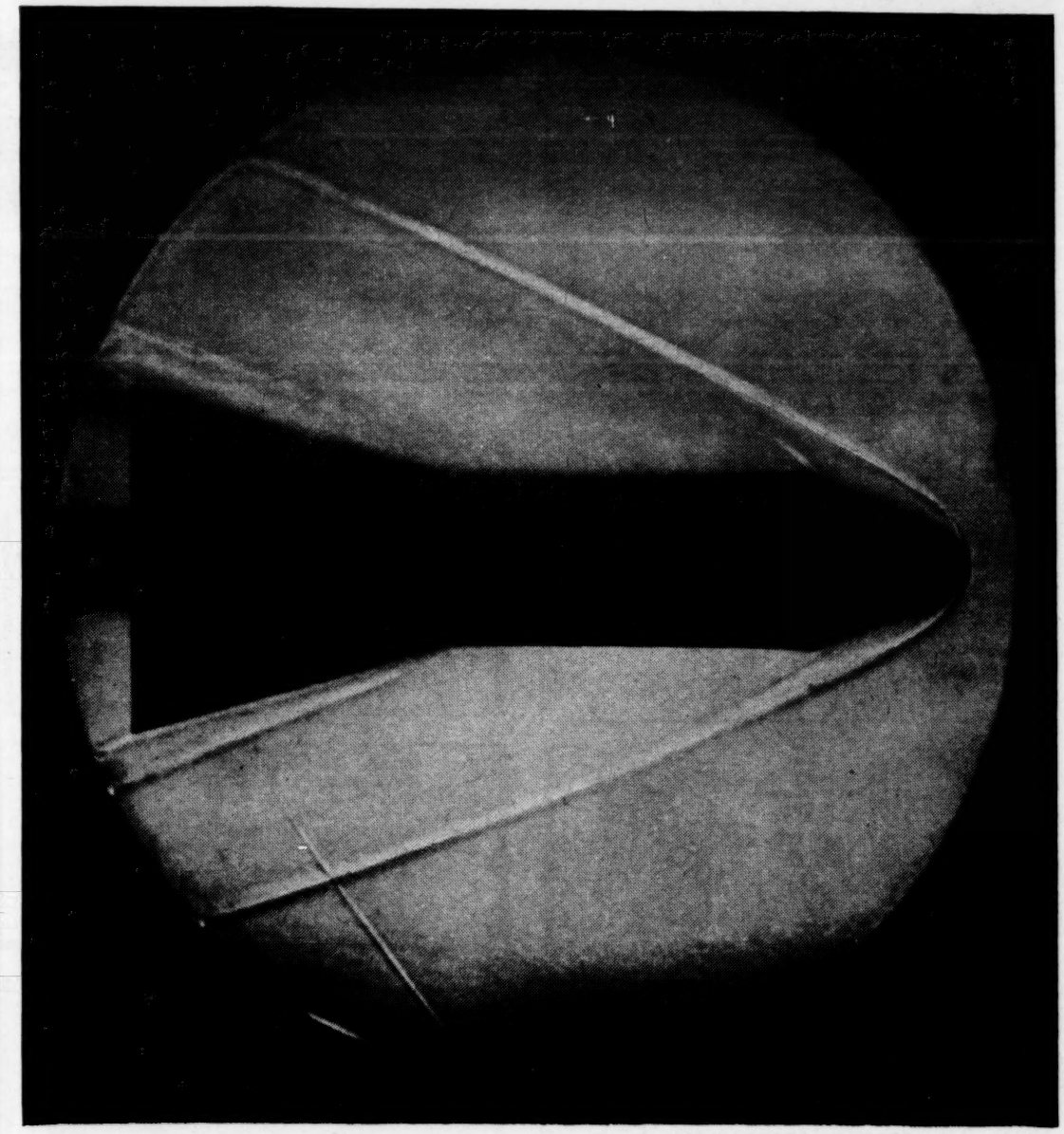
Ben L. Williams, Jr., corporate director of information, Fairchild Stratos Corp., Hagerstown, Md.

S. T. Robinson, staff assistant to the president, Solar Aircraft Co., San Diego, Calif., a subsidiary of International Harvester Co.

Donald S. Butler, contract administrator, Robertshaw-Fulton's Aeronautical and Instrument Division, Anaheim, Calif.

Capt. Neil E. Harkleroad (USN, ret.), special assistant in the Advanced Development Division, Aerojet-General Corp.'s Liquid Rocket Plant, Sacramento, Calif.

Alfonso Tammaro, assistant to the engineering manager of Pratt & Whitney Aircraft Division of United Aircraft Corp., East Hartford, Conn.



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ADVANCED TECHNOLOGY LABORATORIES, A DIVISION OF AMERICAN-STANDARD..... 59
AERONUTRONIC DIVISION, FORD MOTOR COMPANY 84-85
AIRWORK CORPORATION 98
ALUMINUM COMPANY OF AMERICA.....114-115
AMERICAN AIR FILTER COMPANY, INC., DEFENSE PRODUCTS DIVISION..... 57
AMHERST LABORATORIES DIVISION OF SYLVANIA ELECTRONIC SYSTEMS..... 69
AMMON INSTRUMENTS, INC..... 91
ASTEK INSTRUMENT CORPORATION..... 107
ASTRODATA, INC. 94
AVCO CORPORATION, ELECTRONIC & ORDNANCE DIVISION 87

BELL AEROSYSTEMS COMPANY DIVISION OF BELL AEROSPACE CORPORATION.....3rd Cover
BENDIX PIONEER CENTRAL DIVISION, THE BENDIX CORPORATION 75
BENDIX PRODUCTS DIVISION, THE BENDIX CORPORATION 90
BENDIX SYSTEMS DIVISION, THE BENDIX CORPORATION 58
BETHLEHEM STEEL COMPANY..... 15
BOEING COMPANY, THE..... 44
BRISTOL SIDDELEY ENGINES LIMITED.....48-49

CHERRY RIVET DIVISION, TOWNSEND COMPANY 6
CHICAGO AERIAL INDUSTRIES, INC..... 22

DEFENSE SYSTEMS DIVISION, GENERAL MOTORS CORPORATION 80
DELCO RADIO DIVISION, GENERAL MOTORS CORPORATION 13
DEL MAR ENGINEERING LABORATORIES..... 68
DRESSER ELECTRONICS, SOUTHWESTERN INDUSTRIAL ELECTRONICS DIVISION..... 56
DUNN ENGINEERING CORPORATION..... 120
DU PONT DE NEMOURS & COMPANY, INC., E. I. 3

ELASTIC STOP NUT CORPORATION OF AMERICA, ELIZABETH DIVISION..... 5

FAIRCHILD CAMERA & INSTRUMENTS CORPORATION, DEFENSE PRODUCTS DIVISION..... 10
FAIRCHILD CAMERA & INSTRUMENTS CORPORATION, FACSIMILE PRODUCTS DEPARTMENT 82
FLORIDA DEVELOPMENT COMMITTEE, INDUSTRIAL DIVISION 106
FMC CORPORATION ORDNANCE DIVISION..... 108
FORD INSTRUMENT COMPANY DIVISION OF SPERRY RAND CORPORATION..... 17

GENERAL ELECTRIC COMPANY, LIGHT MILITARY ELECTRONICS DEPARTMENT..... 4
GENERAL ELECTRIC COMPANY, SILICONE PRODUCTS DEPARTMENT 74
GOODYEAR TIRE & RUBBER COMPANY, THE—AVIATION PRODUCTS 8-9
GOULD-NATIONAL BATTERIES, INC., NICAD BATTERY DIVISION 12
GRUMMAN AIRCRAFT ENGINEERING CORPORATION 64-65

HEXCEL PRODUCTS, INC..... 61
HITEMP WIRES COMPANY DIVISION OF SIMPLEX WIRE & CABLE COMPANY..... 70
HUGHES AIRCRAFT COMPANY..... 113
HYDRODYNE CORPORATION 81

LAMINATED SHIM COMPANY, INC., THE..... 110
LEWIS ENGINEERING COMPANY..... 86
LIQUIDOMETER CORPORATION, THE..... 118
LISLE CORPORATION, MAGNETIC DIVISION... 101
LITTON INDUSTRIES, INC..... 113
LITTON SYSTEMS, INC., DATA SYSTEMS DIVISION 125
LOCKHEED CALIFORNIA COMPANY DIVISION OF LOCKHEED AIRCRAFT CORPORATION.104-105
LOCKHEED PROPULSION COMPANY DIVISION OF LOCKHEED AIRCRAFT CORPORATION.... 20

McDONNELL AIRCRAFT CORPORATION....4th Cover
McGRAW-HILL BOOK COMPANY, INC..... 119
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY, MILITARY PRODUCTS GROUP.....54-55
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY, ORDNANCE DIVISION.....96-97
NICHOLS COMPANY, W. H..... 77

NORTHROP CORPORATION 16

PANAMA CITY, FLORIDA—COMMITTEE OF 100. 117
PARSONS COMPANY, THE RALPH M..... 100

RCA DEFENSE ELECTRONIC PRODUCTS.....92-93
RCA SEMICONDUCTOR & MATERIALS DIVISION 7
RAYTHEON COMPANY 63
REEVES INSTRUMENT CORPORATION..... 88
REMINGTON RAND UNIVAC DIVISION SPERRY RAND CORPORATION 66
RESEARCH LABORATORIES DIVISION OF UNITED AIRCRAFT CORPORATION..... 121
ROHM & HAAS COMPANY, PLASTICS DIVISION. 14

SANBORN COMPANY 76
SCHULZ TOOL & MANUFACTURING COMPANY. 18
SHELL OIL COMPANY..... 42
SIEGLER CORPORATION 112
SIKORSKY AIRCRAFT DIVISION, UNITED AIRCRAFT CORPORATION 11
SILICONES DIVISION, UNION CARBIDE CORPORATION 24
SYLVANIA ELECTRIC PRODUCTS, INC., ELECTRONIC TUBES DIVISION..... 47

TAPCO GROUP, THOMPSON RAMO WOOLDRIDGE, INC. 116
TEXAS INSTRUMENTS INCORPORATED, COMPONENTS DIVISION 78
TRANS WORLD AIRLINES, INC..... 46

UNITED TECHNOLOGY CORPORATION, A SUBSIDIARY OF UNITED AIRCRAFT CORPORATION 107
UNITED STATES STEEL CORPORATION..... 60

VAPOR HEATING CORPORATION, VAP-AIR AERONAUTICAL DIVISION 109
VOI-SHAN MANUFACTURING COMPANY, A DIVISION OF VOI-SHAN INDUSTRIES, INC.2nd Cover

WESTERN AIRLINES 51

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 122-124
Books 122
EQUIPMENT (Used or Surplus New) For Sale 123

ADVERTISERS INDEX

A & J Machinery Co..... 122
Boreas Corporation 122
General Electric 123
Minneapolis Honeywell, Honeywell Ordnance Div..... 124
Tech Publishers 122
Trane Company 122
Zep Aero 122

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LETTERS

Money Motive

In reference to your article concerning the upgrading of military research in the Oct. 30 AVIATION WEEK (p. 26), it appears that one questionable assumption has been made by the military planners and congressmen. This assumption is that engineers and scientists are working primarily for money. Studies on the motivation of scientists and engineers casts much doubt on this assumption. There are a variety of other goals which the technical man holds higher than money itself. I submit that the following items are the source of much more frustration to the government engineer than the salary itself:

- **The highly centralized** decision-making apparatus in the military takes much of the incentive from the working level.
- **The failure to communicate** downward the reasons behind policies and plans.
- **The frequent changes** in funding and redirection of programs.
- **The extreme difficulty** which a talented and aggressive individual in the military organization finds in attempting to move up to middle management.
- **The general lack of leadership** talent in the middle management ranks.
- **The frequent reorganizations.**
- **The acceptance of contractor-generated** data rather than government-generated data when a conflict exists.
- **The personnel policies** which fail to treat the man as an individual.

The salary matter cannot, however, be completely disregarded, but the reason for its importance should be examined. If an individual working for a contractor is receiving more money than a government employe doing a comparable job, is this not in effect implying that he is doing a better job? The continued emphasis on salary tends to further develop money as the indicator of individual achievement.

Industry salaries are flexible whereas government salary scales are inflexible. Should government increase the salary levels industry would simply raise theirs to maintain the differential. I suggest that the government turn their attention to other methods of giving job satisfaction which will improve the quality of their technical talent in the long run.

LOWELL E. PARKER
Dayton, Ohio

Last Resort Only

I am sure that Capt. Donald A. Smith means well in his letter reference "Ice Removal" AW Oct. 30 (p. 96), but since I was deeply concerned with this accident investigation I feel that it is in order to make the following comments:

- Certainly any pilot with Capt. Sable's background and ability knows of the last resort emergency carburetor ice removal method of backfiring the engine, but this is surely a last resort only when dealing with a high power, supercharged engine, as the engine may be disabled completely by using this procedure due to a damaged gear train or twisted tail shaft. Capt. Sable was also an instructor on aircraft engines and, therefore, would be fully aware of the consequences of using this procedure. There is no way to determine if Capt. Sable used this procedure in a desperate attempt to clear the ice from the engine, but from the sounds of the engine as reported by ground witnesses it is possible that the engine was wilfully backfired in a last attempt to regain power.
- With reference to the statement that "the aircraft struck the ground inverted in a steep attitude," according to witness reports along the flight path, the remaining engine was running spasmodically and surging to full power and abruptly cutting out and then surging to full power again. Also, one witness about two miles back along the flight path from the crash site estimated the aircraft to have passed very close to him and very low. May I point out that a high performance multi-engine aircraft, on instruments, with one engine feathered, one engine windmilling and surging from full windmilling drag to maximum power and at minimum airspeed, and with an unknown increase in stalling speed due to airframe ice—add all these factors to the fact that Sable knew he was getting very low and was trying desperately to gain altitude or hold what he had. This is far beyond the scope of any emergency procedure training and, in my humble opinion, it is also beyond the realm of controllability under these given circumstances.

ROBERT A. DARNALL
Chief Pilot
Johnson and Johnson
Linden, N. J.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Tape's the Answer

The letter sent to you by Mr. J. R. Pritchard (AW Oct. 23, p. 126) reflects an idea that might be good in a few situations, but not all. Unfortunately, many crashes happen before anybody has time to do anything at all—including a chance to brace themselves. Secondly, if an aircraft is in trouble all hands will be needed—especially the copilot and engineer—in order to try to prevent a catastrophe. Thirdly, such factors as low altitude may prevent an ejected crew member from living, and should a successful landing be accomplished with no loss of life except for the ejected crew member it would be a pretty tragic and sticky situation, to say the least.

Now, on the other hand, if the cockpits of all aircraft were equipped with a tape recorder (well protected in a strong, fireproof box) more information might be learned. When switched on by the copilot, this machine would record all the conversation in the cockpit from the first inkling of an emergency situation to the end. The conversation between the pilot, copilot, and engineer could be preserved, or perhaps just the pilot relating everything he can tell about the initial symptoms of the trouble and subsequent effects and experiences while still wrestling the aircraft. Too often ground stations report at accident hearings that a considerable time elapsed between their last contact with the disabled aircraft and the time of the accident. Well, I am not surprised. I would imagine that they were all pretty busy in the cockpit trying to correct the situation. It is during this time that such a tape recorder might prove quite useful.

P. P. WHITE
Dover, Mass.

Spy Is a Spy

Re: 'Spy' Satellites, Washington Roundup, AW July 31, p. 21.

When the Soviets cease to raise issues designed to foment unrest and create political squabbles between countries they will cease to be Communists. Mr. Khrushchev says they intend to bury us. Perhaps by the end of this year he will learn that we do not intend to be buried with our hands folded.

As regards sovereign air space, isn't it obvious that "air space" extends only as far as air itself? Is it not logical for "space" to begin at that point? Of course, the atmosphere just sort of dwindles away to nothing, but an arbitrary limit could be established, say at an altitude at which a satellite, if placed into a perfect circular orbit, would remain indefinitely.

The Russians apparently feel that their sovereignty should extend to infinity. When the moon finally has men on it, will not it, too, become a "spy satellite"? A spy is a spy, no matter at what height it flies; 240,000 mi. away is probably still too close, as far as the Russians are concerned, for us to be observing the manifold deficiencies of the workers' paradise.

Why is it that the other nations of the world cannot agree to observe some practical limit to sovereign air space irrespective of Russia's "nyet"? There used to be such a thing as a quorum. Now days one veto is enough to squash an issue that is of great importance to everyone else.

It seems to me we might place Russia in its proper perspective in world affairs by the effective use of ridicule. There must be some office in our government that keeps tabs on the crass contradictions that are continually being uttered by one Communist organ or another. Couldn't we present these inconsistencies in such a manner that other nations and people would eventually come to see the Soviets in their true light? Mr. Kennedy has said that we should seek means to fight the Communists with their own weapons. This could very well be an effective one.

I realize this letter has tended to become more political than technical, but the two areas seem to have become inseparable in these perilous times.

FERGUSON J. BYARS
Northridge, Calif.